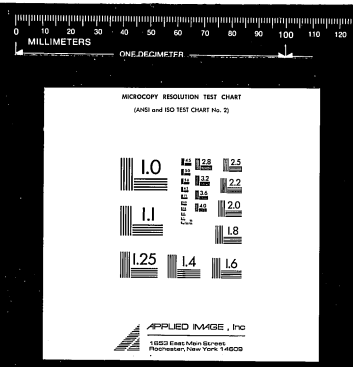


14:1

Compilation © 1993 University Publications of America.
All rights reserved.

Thomas A. Edison Papers

A SELECTIVE MICROFILM EDITION

PART III
(1887–1898)

Thomas E. Jeffrey
Microfilm Editor

Gregory Field
Theresa M. Collins
David W. Hutchings
Lisa Gitelman
Leonard DeGraaf
Dennis D. Madden
Mary Ann Hellrigel
Paul B. Israel
Robert A. Rosenberg
Karen A. Detig
Gregory Jankunis
Douglas G. Tarr

Editors

Reese V. Jenkins
Director and Editor

Sponsors
Rutgers, The State University of New Jersey
National Park Service, Edison National Historic Site
New Jersey Historical Commission
Smithsonian Institution

University Publications of America
Bethesda, Maryland
1993

Edison signature used with permission of McGraw-Edison Company.

Thomas A. Edison Papers
at
Rutgers, The State University
endorsed by
National Historical Publications and Records Commission
18 June 1981

Copyright © 1993 by Rutgers, The State University

All rights reserved. No part of this publication including any portion of the guide and index or of the microfilm may be reproduced, stored in a retrieval system, or transmitted in any form by any means—graphic, electronic, mechanical, or chemical, including photocopying, recording or taping, or information storage and retrieval systems—without written permission of Rutgers, The State University, New Brunswick, New Jersey.

The original documents in this edition are from the archives at the Edison National Historic Site at West Orange, New Jersey.

ISBN 0-89093-702-8.

THOMAS A. EDISON PAPERS

Reese V. Jenkins
Director and Editor

Thomas E. Jeffrey
Associate Director and Microfilm Editor

Robert A. Rosenberg
Managing Editor, Book Edition

Helen Endick
Assistant Director for Administration

Associate Editor
Paul B. Israel

Research Associates
Theresa M. Collins
David W. Hutchings
Karen A. Detig

Intern
Gregory Jankunis

Assistant Editors
Keith A. Nier
Gregory Field
Lisa Gitelman
Martha J. King

Secretary
Grace Kurkowski

Student Assistant
Bethany Jankunis

BOARD OF SPONSORS

Rutgers, The State University of New Jersey
Francis L. Lawrence
Joseph J. Seneca
Richard F. Foley
Rudolph M. Bell
New Jersey Historical Commission
Howard L. Green
National Park Service
John Maounis
Maryanne Gerbauckas
Nancy Waters
George Tselos
Smithsonian Institution
Bernard Finn
Arthur P. Molella

EDITORIAL ADVISORY BOARD

James Brittain, Georgia Institute of Technology
Alfred D. Chandler, Jr., Harvard University
Neil Harris, University of Chicago
Thomas Parke Hughes, University of Pennsylvania
Arthur Link, Princeton University
Nathan Reingold, Smithsonian Institution
Robert E. Schofield, Iowa State University

CORPORATE ASSOCIATES

William C. Hittinger (Chairman), RCA Corporation
Edward J. Bloustein, Rutgers, The State University of New Jersey *
Gees Bruynes, North American Philips Corporation
Paul J. Christiansen, Charles Edison Fund
Philip F. Dietz, Westinghouse Electric Corporation
Roland W. Schmitt, General Electric Corporation
Harold W. Sonn, Public Service Electric and Gas Company
Morris Tanenbaum, AT&T

*Deceased.

FINANCIAL CONTRIBUTORS

PRIVATE FOUNDATIONS

The Alfred P. Sloan Foundation
Charles Edison Fund
The Hyde and Watson Foundation
Geraldine R. Dodge Foundation

PUBLIC FOUNDATIONS

National Science Foundation
National Endowment for the Humanities
National Historical Publications and Records Commission

PRIVATE CORPORATIONS AND INDIVIDUALS

Alabama Power Company
Amerada Hess Corporation
Anonymous
AT&T
Atlantic Electric
Association of Edison Illuminating Companies, Inc.
Battelle Memorial Institute
The Boston Edison Foundation
Cabot Corporation Foundation, Inc.
Carolina Power & Light Company
Consolidated Edison Company of New York, Inc.
Consumers Power Company
Corning Glass Works Foundation
Duke Power Company
Entergy Corporation (Middle South Electric Systems)
Exxon Corporation
Florida Power & Light Company
General Electric Foundation
Gould Inc. Foundation
Gulf States Utilities Company
Idaho Power Company
International Brotherhood of Electrical Workers
Iowa Power and Light Company
Mr. and Mrs. Stanley H. Katz
Matsushita Electric Industrial Co., Ltd.
McGraw-Edison Company
Minnesota Power
New Jersey Bell
New York State Electric & Gas Corporation
North American Philips Corporation
Philadelphia Electric Company
Philips International B.V.
Public Service Electric and Gas Company
RCA Corporation
Robert Bosch GmbH
Rochester Gas and Electric Corporation
San Diego Gas & Electric
Savannah Electric and Power Company
Schering-Plough Foundation
Texas Utilities Company
Thomas & Betts Corporation
Thomson Grand Public
Transamerica Delaval Inc.
Westinghouse Educational Foundation
Wisconsin Public Service Corporation

START

102

A Note on the Sources

The pages which have been filmed are the best copies available. Every technical effort possible has been made to ensure legibility.

PUBLICATION AND MICROFILM
COPYING RESTRICTIONS

Reel duplication of the whole or of any part of this film is prohibited. In lieu of transcripts, however, enlarged photocopies of selected items contained on these reels may be made in order to facilitate research.

Notebook, N-88-02-17

This notebook, which is not standard sized, covers the period February-March 1888. It was used primarily by James W. Gladstone for notes, tables, and calculations regarding fiber carbonization, condensers, "thermo battery" experiments, and the bleaching of tobacco. There are also scattered notes by Arthur E. Kennelly. Inserted into the book are about 20 loose pages containing instructions from Edison to Gladstone, a note from Edison to John [Ott?] relating to Gladstone's work, and various notes by Gladstone and Kennelly. The spine is labeled "56." The pages are unnumbered, and the book has been used in both directions. Several pages have been removed from the book. Approximately 140 pages have been used.

Experimental Results.

No 41 Carbonization of fibres blotting paper etc. Mains

Fibres etc	Carbonized in	Set current through
Rosewood	Pot Carbon	15 volts
Black Walnut	" Carbon	15 "
Elm	" Plumbago	12 "
Birch	" Carbon	15 "
Hickory	" Carbon	18 "
Willow	" Plumbago	15 "
Rock Maple	" Carbon	15 "
Lancewood	" Carbon	23 "
Jute Twist 1/32 in	" Carbon	12 "
Jute " " "	" Plumbago	12 "
Manilla " " "	" Carbon	18 "
Manilla " " "	" Plumbago	15 "
Cotton " " "	" Plumbago	18 "
Broomcorn Split	" Carbon	18 "
Broomcorn Split	" Plumbago	18 "
Broomcorn Scraped	" Carbon	15 "
Blotting paper pressed	" Carbon	40 "
Blotting paper pressed	" Plumbago	40 "

Crucibles used (Iron box melted at bottom)

Bright red heat. Time from 2 to 3 hours - Boiled gradually in hot ashes under pot stove.

Finished expt. 17 February 1888.

57

Condenser Experiment.

Remade condenser No 318 putting in 6 sheets fine paraffin paper or 3 sheet thick do
It contains 100 sheets foil in 3 equal divisions
Made condenser No 320 using 8 sheet of thin paraffin paper for insulation total Capacity
It contains 100 sheets foil in 3 equal divisions –

100

Thermo Battery Experiment –

Use as bases.	Oxidizers
Glacial Phosphoric Acid	Peroxide Lead
Chloride Zinc.	Peroxide Manganese.
Sod. di Hydrogen Phosphate	Chlorate of Potash.
Di-Sod. Hydrogen Arsenate.	Nitre.
Boric Acid.	Chromic Acid.
Hydrogen Potassium Hyposulphate	Bichromate Potash.
Hydrogen Borate.	Bichloride Tin.
Hydrogen Basic Sulphate.	Peroxide Iron.
Ammonium Hyposulphate.	Permanganate Potash.
Nitrate Ammonia.	Carbolic Acid.
Water Glass.	Sulphuret of Bisquium.
Caustic Soda.	Red Lead.

Apparatus and Electrodes and Directions
Jin × 1/4 Test Tubes. over bunsen burner.
Ordinary Sangent Galvanometer Coarse & fine coils.
Electrodes insulated in cover of test tube.
Carbon & silver
Carbon & platinum
Carbon & Iron
Carbon & Nickel
Carbon & Copper
Mel portion of Base G.P.A. and put in thimbleful of peroxide manganese. Heat the test tube just as high as it will stand. Stir the liquid with the electrodes and take the deflections on both coils –
See that they start from zero. Use switch –
See if there is much polarization by holding current closed for a little while.
Clean test tube – put in fresh charge of Glacial Phosphoric Acid, and then put in thimbleful of peroxide lead, and so on, using as base, Glacial Phosphoric Acid and successively putting in each of the oxidizers on list –
Then take Chloride Zinc as base successively putting in each of the oxidizers on list and so on breaking each base on list with each of the oxidizers in rotation.

Bases	Oxidizer	Positive Electrode	Negative Electrode	Tangent Galvanometer deflections Readings taken every minute. Coarse 1.5 resist.				Fine 80 ohm resist.				S Circuit 1 min. Coarse	Fine
Glacial Phosphoric Acid	Chlorate of Potash												
" "	"												
" "	"												
" "	"												
" "	Bioxide of Manganese	Iron	Carbon		19			45				15	35
" "	"	Platinum	Carbon		17			39				15	39
" "	"	Copper	Carbon		22			49				45	40
" "	"	Platinum	Carbon		10			29				3	15
" "	"	Carbon	Platinum		3	4		10				3	15
" "	Nitre	Copper	Carbon	35	53	55		46	55	55		47	50
" "	"	Iron	Carbon	20	29	33		36	39	45		11	30
" "	"	Nickel	Carbon	25	10	5		40	25	15		5	15
" "	"	Silver	Carbon	20	33	29		45	45	45		21	40
" "	"	Carbon	Platinum	20	20	20		15	13	10		19	7
" "	Chromic Acid												
" "	"												
" "	"												
" "	"												
" "	"												
" "	Bichromate of Potash	Iron	Carbon	22				55				18	46
" "	"	Copper	Carbon	10				44				9	[illegible]

Bad Mat.

Bases.	Acid or Jors	Positive Electrode	Negative Electrode	Galvanometer readings every minute. Coarse Coil				Fine Coil				S. Circuit 2m. Coarse	Fine
Glacial Phosphoric Acid	Bichromate of Potash	Nickel	Carbon.	14				15				2	13.
" "	"	Silver	Carbon.	0				14				0	1.
" "				0				0				0	0.
" "	Peroxide Lead	Iron	Carbon.	10	23	25		11	43	50.		30	45.
" "	"	Carbon	Platinum	20	15	5		29	25	29.		0	4
" "	"	Nickel	Carbon.	3	7	5		13	23	21		6	15
" "	"	Silver	Carbon.	45	53	49		44	51	58		53	53.
" "	"	Copper	Carbon.	33	39	40		53	53	54		40	53.
" "	Peroxide Iron	Carbon	Platinum	0	0	0		1	2	0			
" "	"												
" "	"												
" "	"												
" "	"												
" "	"												
" "	Bichloride Tin												
" "	"												
" "	"												
" "	"												
" "	"												
Potassium	(Iron)	Tannate of Iron	Silver	Carbon	15	0	0	55	2	0		10	50
"	"	"	Platinum	Carbon	30	10	15	25	38	40	49	45	40
"	"	"	Silver	Carbon	38			37				33	35
"	"	"	Nickel	Carbon	40			38				50	45

Bases.		Oxidizers	P. Electrode	N. Electrode	Galvanometer readings every minute — Coarse Coil				Fine Coil				S. Circuit 2m — Coarse	Fine
Potash	Platinum	Phosphoric Acid	Carbon	Platinum		5			3				4	6
	"	Bimanganate of Potash	Iron	Carbon	2	1	1		2	5	6		1	7
	"		Copper	Carbon	15	15	17		43	45	47		17	46
	"		Carbon	Platinum	5	6	4		21	17	18		3	7
	"		Nickel	Carbon	5	3	3		13	11	6		2	10
	"		Silver	Carbon	15	11	11		40	36	35		10	33
Red Lead	✓	Sulphuret of Potassium	Copper	Carbon	45	55 same off		5 C	55	33	5 C		28	27
Sulphur	✓		Nickel	Carbon	40	23			35	29			23	26
	✓		Iron + Carbon			30	32		61	34			28	38
Oxalic	✓		Carbon	Platinum	8	6	6		15	6	6		8	8
	✓		Silver	Carbon	15				12				18	20
		Red Lead	Copper +	Carbon	13	13	10		49	45	40		9	40
			Iron	"	5	5	5		15	17	17		5	7
			Silver		5	7	10		18	25	29		9	24
			Carbon	Platinum	4	3	3		18	10	12		3	10
			Nickel	Carbon	7	5	5		19	33	21		5	5
	Chloride of Zinc	Bioxide Lead												
	"	"												
	"	"												
	"	"												
	"	"												
	"	"												
	"	Bioxide of Manganese												
	"	"												

Bases	Oxidizers	P Electrode	N Electrode	Low ~~[illegible]~~ Red ~~[illegible]~~ ~~[illegible]~~								After S Circuit 2m.	
				a	b	a^s	b^c	a	b	a^c	b^{sc}	Coarse	Fine
Chloride Zinc	Bioxide of Manganese									1230		2.358	
" "										23		34	
" "	Chlorate Potash									1272			
" "	"								3708			0432	
" "	"										76	74	
" "	"								3955				
" "	"									77	08	172	
" "	Nitre							316		116		404	86
" "	"							2765		4		12 0258	
" "	"							3055		56			
" "	"							1302		61		2	0.0772
" "	"												1.5
" "	"							1557		7		4	120258 0
" "	"			1111									300
" "	Chromic Acid			75									
" "	"			2322									
" "	"			333									
" "	"			5552									
" "	"			75					2477				
" "	"								34				
" "	"								9908				
" "	"			28	4416				7431				
" "	"			348564					4018			2 2263	
" "	"								4	2169		4 21	
" "	Bichromate of Potash			277	3056							2 4.	
" "	"			126	33				1263	27			
" "	"			1509	18								
" "	"				2								
" "	"												
" "	"												
" "	"												
" "	Bichloride Tin	Iron	Carbon	60	40	31	20	6	4	8	3		
" "	"	Copper	Carbon	60	4	16	13	8	17	11	10		

Bases	Oxidizers	P. Electrode	N. Electrode	Low Carbon Steel Copper Col. Copper		S. C. 2 min Copper		Red Heat 5 minute Red Iron Col. Copper		After Cooling Copper		Now Current 2 m. Copper Iron
				Copper	Iron	Copper	Iron	Copper	Iron	Copper	Iron	
Chloride Zinc	Bichloride Iron	Nickel	Carbon	2	19	1	1	N 7½ S 5	N 7 S 8	N 11	N 15	
"	"	Silver	Carbon	25	12	12	12	13	20	9	16	
"	"	Carbon	Plat	5	8	2	8					
"	Peroxide Iron											
"	"											
"	"											
"	"											
"	"											
"	Permanganate Potash	Iron	Carbon	Copper 32	Iron 30	Sort 2 min Copper 34	Iron 30	26	29	30	25	
"	"	Copper	Carbon	40	32	32	22	27	22	17	17	
"	"	Nickel	Carbon	13	15	10	12	7	6	3	2	
"	"	Silver	Carbon	16	25	5	18	15	10	7	9	
"	"	Platinum	Carbon Pt	3	5	1	23	—	—	—	—	
"	Carbolic Acid	Carbon						20	19	15	13	
"	"	Iron	C	21	6	21	6	2	3	1	1	
"	"	Cu	Carbon	11	11	6	3	5	5	10	25	
"	"	Ni		3	15	8	15	5	15	6	13	
"	"	Ag		18	24	16	31	13	26	11	27	
"	"	Pt		6	8	3	1	4	16	5	4	
"	Sulphuret of Potassium	Iron		3	4	3	4	11	26	19	20	
"	"	Cu		6	19	8	11	18	24	15	19	
"	"	Ni		12	36	5	15	2	15	4	12	
"	"	Ag		8	6	5		14	26	5	15	
"	Red Lead	Pt		4	6			4	10	3	11	

Bases	Oxidizers	P Electrode	N Electrode	At Intervals of minute - Coarse Coil	Fine Coil	After S.C. 2 min. Coarse	Fine
Chloride Zinc	Red Lead				1192 / 32	2146 / 24	
" "	"				2384	5584	
" "	"			754 / 32	3576	6138	
" "	"			1508	3571 / 78		
Sodium & Hydrogen Phosphate	Peroxide Lead			2263	2065 / 52	07 29 6 11	
" "	"			2412 / 78	2705	3.6 4 8 2	
" "	"			1930 24	2775 / 32	10 9 4 4 6	
" "	"			1655 96	1094		
" "	"			1551 48 11	1871		1 3/4
" "	Peroxide of Manganese			1094 46	1883		218.88 / 18
" "	"				3/2 / 1/2		1 1/2 / 3/4
" "	"			7172			237 / 365.0
" "	"			72			
" "	"				1129 / 32		29.20
" "	Chlorate Potash			1459 32 / 3011	2858		
" "	"				2817		
" "	"				4572 / 78		
" "	"				3658 / 26		
" "	"				3069 / 8		
" "	"				3566 / 14		
" "	Nitre				4499		
" "	"				2473 / 23		
" "	"						
" "	"						
" "	"						
" "	"						

| Bases | Oxidizers | P Electrode | N Electrode | At Intervals of minute | | |

Bases	Oxidizers	P Electrode	N Electrode
Sodium di Hydrogen Phosphate	Permanganate of Potash.		
" "	Carbolic Acid		
" "	"		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Sulphuret of Potassium		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Red Lead.		
" "	"		
" "	"		
" "	"		
Di Sodium Hydrogen Arsenate	Peroxide Lead		
" "	"		
" "	"		
" "	"		
" "	Peroxide of Manganese		

At Interval of minute

Coarse Coil		Fine Coil		Effect S Circuit 2m	
				Coarse	Fine.
94	1.377			1.377	
21	381	384		94	
56	1.4183	21		5552	
21		363		4131	
		2064		16862	
		75		2931	
		384		.07293	
		768			
	11853	1102			
	94	2012			
	5932	21			
	4149	9653		07168	
	0501	4016		23432	
	2511	0.9554		11716	
	7563	0.9549		08201	
		0.5555			
		07			
	05432	09516			
	2521	07563			
	1265	2013			
	08237	70			

Bases	Oxidizers	P. Electrode	N. Electrode	At intervals of minute – Coarse Coil	Fine Coil	4 Hour Circuit 2m. Coarse	Fine
Bi Sodium Hydrogen Arsenate	Peroxide of Manganese						
"	Chlorate Potash			4.711 / 24 / 10844 / 14433 / 16 0174 / 5 0.57 / 24 0261	1609 / 12 / 9202 / 4803 / 57232 / 78 / 40956 / 3 1564 / 19 9609 / 24 02	16 0174 / 16 0174	
"	Nitre					17 6191 / 16 0174	
"	Chromic Acid	1.151 / 32 / 2302 / 3453 / 36832 / 29 4656 / 18 9224 / 1000 / 1871.2		1.904 / 24 / 7856 / 5 7956 / 6677 / 3338 / 1621 / 100 / 2004 / 26708 / 333 / 3043	1.594 / 1/4	4 17 6191 / 4444	2.607 / 24 / 9901 / 33 / 18802 / 2903 / 28832 / 78 / 23 0656 / 2 0824 / 24 5496 / 12 2956 / 9194 / 58
"	Bichromate of Potash					2.607 / 24 / 10 4428 / 7854 / 18654 / 4319 / 23957	
"	Bichloride Tin					17726 / 4443	2215

Bases	Oxidizers	P. Electrode	N. Electrode
& Sodium Hydrogen	Perchloride Iron		
Arsenate	"	5681	
"	"	54	
5152	"	32724	
34	"	19043	
2068	Peroxide Iron	193154	
2056	"	2577	
154	"	284731	
1516	"		
1855	"	1601	
1855	"	32	
2627	"	3202	
52	"	4803	
	"	5123	
	"	75	
	Permanganate of Potash	20955.56	
		3256224	
		3996096	
		28425	
		10957	
17516	Carbolic Acid	24	
1		4	
157644		60	
4		34	
394		10	
2.548		78	
52		8	
4496		8	
6744		8	
7393		8	
1		8	
39		8	
1		8	
1		8	
1

Bases	Oxidizers	P. Electrode	N. Electrode
Dr. Sodium Hydrogen	Red Lead		
Arsenate "	"		
" "	"		
" "	"		
Boric Acid	Peroxide Lead		
" "	"		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Peroxide of Manganese		
" "	"		
" "	"		
" "	Chlorate Potash		
" "	"		
" "	"		
" "	"		
" "	Nitre		
" "	"		
" "	"		

At Intervals of - minute.

Coarse Coil				Fine Coil				After Switch 2 m. Coarse	Fine
72	49	55	60	48					
300	1151	1132	1733	1111					
					1151			3051	
					32			32	
					2302			3024	
					3453			6	243
		1439			3682			10	17511
		55			78			5	327
		2455						15	17131
		4377		2936	56				
		4577	38	2778	24			1111	
			78					2	
	36	58	24	2171	96			1111	
	50	009	6	1713	1		1/4	1371	
	3566	584						1555	1017
	1713			1300	8			21	329
	7995							5466	
		2						24	64 346
			1017	1627	5			23	3086
			4	1017	4			15	131
			4190	1112	25			120	
			262	488					
			4			1733			
			52			32			2¾
						3466			1½
						5198			
						5456			
						78			
					4	3648			
					3882	92			
					4322	568			
					1713	1			
					2754	25			

Bases	Oxidizers	P Electrode	N Electrode
Boric Acid	Nitric		
" "	Chromic Acid		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Bichromate of Potash		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Bichloride Tin		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Peroxide Iron		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Permanganate of Potash.		
" "	"		

At Intervals of minute - Coarse Coil			Fine Coil						Effect of Circuit 2m. Coarse	Fine
74	47	49							3.489	
	1073								34	
					1151					
					32				7924	
					3303			10	43	
					3483					
					3632			11	3564	
					71			59	177	
					3946			177	531	
				25	8214					
				25	7296			1	2.366	
				17	13				59	
				10	97				29	57
					1073					
					32					
					2146					
				3	219					
				3	3326				11835	
					71				9	
				27	7648			4	10651	
				26	6352				266.	
				26	7208					
				19	958					
				1	509		3/4			
				0	029					
				1	48					

Bases	Oxidizers	P Electrode	N Electrode
Boric Acid	Permanganate of Potash		
"	"		
"	Carbolic Acid		
"	"		
"	"		
"	"		
"	"		
"	"		
"	"		
"	Sulphuret of Potassium	"	"
"	"		
"	"		
"	"		
"	Red Lead		
"	"		
"	"		
"	"		
Hydrogen Potassium & Hydrosulphate	Peroxide Lead		
"	"		
"	"		
"	"		
"	Peroxide of Manganese		
"	"		

At Intervals of minute										After S. Circuit 2min	
Coarse Coil				Fine Coil						Coarse	Fine
70	460				1026					2.75	
					32					24	
					2072						
				3	108					1 00	
				9	1552					2.5	
					78					13.5	
				25.5	16					4.7	
				232.0	4					.13	2.5
				255	56						
				1252.1			14			25.5	
				1933							

Bases	Oxidizers	P Electrode	N Electrode	At Intervals of minute - Coarse Coil				Fine Coil				After 5 Circuit 2m. Coarse	Fine
Hydrogen Potassium } Hydrosulphate }	Bicoxalate of Manganese }			64	45					1.541		2052	
"	"						32			35		34	
"	"						71			1.052			
"	"	Chlorate Potash					256			4623		5205	
"	"	"					23			4937		6156	
"	"	"					2496			71		6278	
"	"	"					1046			39496		3251	
"	"	"					14500			2751		10465.2	
"	"	"								14636			
"	"	"								9612		6976	
"	"	"								941		7	
"	"	Nitre		75	62		37			14		2441	1832
"	"	"			1.583		1.641					34	
"	"	"								1.882		3726	
"	"	"								35		34	
"	"	"								3761			
"	"	"								5446		7944	381
"	"	"								60324		11205	
"	"	"								78			
"	"	Chromic Acid								45792		12024	
"	"	"								1525		6351	
"	"	"								4997672		19056	
"	"	"								1003			
"	"	"								2192	2/4		
"	"	"										127034	
"	"	"										15	
"	"	Bichromate of Potash }									64	1205360	
"	"	"										451.	
"	"	"											
"	"	Bichloride Tin											

Bases		Oxidizers	P Electrode	N Electrode
Hydrogen	Bassium	Bichloride Tin		
Anhydrosulphate		"		
"	"	"		
"	"	"		
"	"	Peroxide Iron		
"	"	"		
"	"	"		
"	"	"		
"	"	"		
"	"	"		
"	"	Permanganate of Potash		
"	"	"		
"	"	"		
"	"	"		
"	"	Carbolic Acid		
"	"	"		
"	"	"		
"	"	"		
"	"	"		
"	"	Sulphides of Potassium		
"	"	"		
"	"	"		
"	"	"		

At Intervals of minute.

Coarse Coil				Fine Coil				Effects Current on Coarse	Fine
79	55	57				1129		5752	
	1129	1541				32		34	
						3555		20605	
						1257		15456	
						1571		17568	
						71		17581	
				30	55	44		2752	
				32	69	6			
				35	67	84		350	
				26	7				
				9	39		1/2	1/2	
				75					
						15241		75168	
						32		13	
						30932		32-77184	
						4623		310	
						4931		3	
						76		11	
						21447		6	
						3415		6	
						37663			
						26			
						1139			
						17			

Bases	Oxidizers	P Electrode	N Electrode
Hydrogen Potassium	Red Lead		
Hydrosulphate			
Hydrogen Borate	Peroxide of Lead		
	Peroxide of Manganese		
	Chlorate Potash		
	Nitre		

Intervals of minute –

Coarse Coil	Fine Coil

After Circuit 2m.

Coarse	Fine

Bases	Acidizers	P Electrode	N Electrode
Hydrogen Borate	Nitric		
" "	Chromic Acid		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Dichromate of Potash		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Bichloride Tin		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Peroxide Iron		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Permanganate of Potash		
" "	"		
" "	"		

At Intervals of minute.

Coarse Coil				Fine Coil				After 5 Circuit 2m. Coarse	Fine
1	40	44	50	52				2.907	
	139	966	1.192	1.28				34	
					139			116.25	
					36			5721	
					1675			05.1235	
					25.17			44419	
					2.6845			153257	
					25				
		1.28		3.4784					
		32		1.8793				88835	
		2.162		2.094				177675	
		3.2445		1.8.2.17				44419	
		4.4982		7.6.1.7.				1.2095	
		78							
		5.1036				966			
		2.6944				32			
		3.1976				1930			
		1.832				2.5.9			
		15.349				3.09.23		4.197225	
						71		2443.	
		1.192				3.4.72.96			
		32				1.6.5.24			
		2.3.8.24				2.4.1.1.36			
		2.5.76				1.832.7			
		3.5.1441				1.9.7.8.6		184	
		71				555			
		3.5.1.5.2						88835	
		3.5.0.0.8						9	
		2.6.7.5.2.32						1.186	
		2.6.7.5.2.5						2.6	
		1.6.3.2.5						305.	
		1.6.4.3.7							

Bases	Oxidizers	P Electrode	N Electrode
Hydrogen Borate	Permanganate of Potash		
" "	Carbolic Acid		
" "	"		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Sulphuret of Bismuth		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Red Lead		
" "	"		
" "	"		
" "	"		
" "	"		
Hydrogen Bismuth Sulphate	Peroxide Lead		
" "	"		
" "	"		
" "	"		
" "	"		
" "	Peroxide of Manganese		

At intervals of minutes

Coarse Coil				Fine Coil				After 5 Circuit Bm Coarse	Fine
76	58	50	56					4056	
	1601	1.192	1.483			1.604		34	
						30		1604	
						3205		1048	
						4709		1654	
		1.192				5123		6827	
		32				71		2045	16
		2284				4095	6		
		2276				3158	4		
		3147				26			
		26				3996	96		
		20 5152				3158		.4095	
		2400 5				3			
		39 7532				13 3793	6	1½	
		2640 16				32		1365	
		9579	34					9	
		1365						9155	596
					1483			34	
					34				
					2966				
				4	449				
					4 7456				
					71				
				37	9 6 464				1365
				933	7 9 3			1365	
					370 5 64		1½	4 1119	194
				2034	31			37	5
			1653	4				1	

Bases	Deoxidizers	P. Electrode	N. Electrode	At intervals of minute: Coarse Coil				Fine Coil				After 5 minutes: Coarse	Fine
Hydrogen Potassic Sulphate	Dioxide of Manganese			80	5.681			1.805				5.681	
" "	"			61	1.805			12				34	
								3.601					
" "	Chlorate Potash							5.45				32.724	
								5.769				17.043	
" "	"							46					
" "	"							46.208				19.154	
" "	"							4.043				46.577	
" "	"							4.505				24.971	
" "	"							2.197					
" "	"							16.697					
" "	Nitre												
" "	"												
" "	"												
" "	"												
" "	"												
" "	Chromic Acid												
" "	"												
" "	"												
" "	"												
" "	"												
" "	Bichromate of Potash												
" "	"												
" "	"												
" "	"												
" "	Bichloride Tin												

34

1431
2
2862
4 pints
4 34.5

Bases	Oxidizers	P. Electrode	N. Electrode
Hydrogen Potassic Sulphate	Bichloride Iron		
"	"		633
"	"		75
"	"		356
"	Peroxide Iron	2.41	
"	"	2.496	
"	"	1405	
"	"	791	
"	"	127	
"	"		
"	"		
"	Permanganate of Potash		54
"	"	1328	
"	"	33	
"	"	3456	
"	"	3484	
"	"	4244	
"	Carbolic Acid	33	
"	"	2974	
"	"	3314	
"	"	1905	
"	"	1409	
"	"		
"	"		
"	"		
"	Sulphuret of Potassium		
"	"		
"	"		
"	"		
"	"		
"	"		

At Intervals of minute

Coarse Coil						Fine Coil						After 5 Cruikshanks	
												Coarse	Fine
	75	32	50	55	45	57	2 53.	1236				309	
								32				34	
								2472				2324	
								3708				9243	
		1328						2955				10 4754	
		32						71				5 2377	
		2656						3464				15 7131	
		3984						7168					
		4244						3055					
		78						1056					
	33	9968						157				1/2	324
	29	7472											
	33	1468				10	151	73					
	19	05				1.192		1328				3736	
	14	09				82						34	
	127					2354						19944	
						576						11208	
	1/4					3814						12 0244	
	1429					78						6.35 1 5	
		32			24	5656						19 6 36	
		2854			26	1005							
	42	87				2975	2						
						1905				10		127	
	457	28				1070						127	
		70				127		1/3				(635	
	26	5254						1/2	9 8			17	
	32009	6							6 6			889	
	356											32	
	1905											35	127
	1460											4	2159
	(12)												36.

Bases	Oxidizers	P. Electrode	N. Electrode
Hydrogen Potassic Sulphate	Red Lead	1192	
		933	
		259	
		257	
		2.1144	
		75	
		1.1.3	
Ammonium-Hypophosphate	Peroxide lead	1005	
		2451	
		1261	
		2526	
		421	
		2941	
	Peroxide of Manganese	933	
		1066	
		2999	
		2956	
		75	
		2388	
		2.1999	
		2.2576	
		63	
	Chlorate Potash	1065	
		5421	
		Nil. 8121	
		2	
		92621	
		263.	
	Nitre		

Abstracts of minutes -

		Coarse Coil		Fine Coil			Effect S. Circuit 2m. Coarse	Fine
35	39 (40)	50	43	54	45	55	2.4277	
75	49	1192	933	1.377	1.	1.429	34	
					137		9908	
					2.2544		7 4.31	
		0032			4.1391		1 4.218	
		75			4.4064		4 2.109	
		256			75		1 6.327	
		2244			1.2.573			
		2496			4.448			
		126 3		5			33 68	
		3.3.		3	4.3 6 9 9 2	3/m	23 68	4.21
		1/2		1	2 6 3			378
		2.26		2	1 7 3		1434	
							75	
		8					2.5.5	
		782					4.2.7	
		75					4.5.7	2.8
		1566						75
		2346					6.5.8	2.4
		75					6.0.9	
		2.50				3	3.5.6.7	5.7
							26	
		2010					240.	
		1965					939	
		1.87					75	
		1.9.3					1.6.7	
		1.2.6					2.5.8.4.5	
		1.6.8.7					2.9.7.6	2
		3/m					1.9.9.4.1	1
		1/2					2.0.4.1	
							1.2.6.3	
							1.3.1	

Bases	Oxidizers	P Electrode	N Electrode	At Intervals of minute: Coarse Coil				Fine Coil				Flow S Circuit 2 m: Coarse	Fine
Ammonium	Nitric												
Hydrophosphate.	Chromic Acid			67	2.358			466				2.358	
"	"							33				4432	
"	"			44	119	60		1933				6714	
"	"			466	1157	1733		2868				10172	
"	"							3033				4002	
"	"							5				1203.8	
"	"							2473	96				
"	"							3163	4			1157	
"	"	Bichromate of Potash						2711	36	1/2		2302	
"	"							1200				4602	
"	"							1311				6832	
"	"								1733		56	75	
"	"								33			4656	
"	"								4466			29	
"	"								57	84		2519	24
"	"	Bichloride Iron							13	4856		119	2896
"	"									75		126	
"	"								4336	4848		169	
"	"								4	1922		2	
"	"								4325	5648			
"	"								1203			114	
"	"								3123	4			
"	"	Peroxide Iron											
"	"												
"	"												
"	"												
"	"	Permanganate of Potash											
"	"												

Bases	Acidizers	P Electrode	N Electrode
Ammonium Hydrophosphate	Permanganate Potash		
	Carbolic Acid		
	Sulphuric Acid of Potassium		
	Red Lead		
Nitrate Ammonia	Peroxide Lead		
	Peroxide of Manganese		

Intervals of minute

Coarse Coil	Fine Coil	After Commutation Coarse	Fine

Bases	Oxidizers	P Electrode	N Electrode
Nitrate Ammonia	Peroxide of Manganese		
" "	"		
" "	"		
" "	Chlorate Potash		
" "	"		
" "	"		1 29
" "	"		32
" "	"		2.562
" "	"		3848
" "	"		10992
" "	Nitre		20
" "	"		34 7638
" "	"		21 6444
" "	"		31 67376
" "	"		10 4
" "	"		2.10 3.
" "	"		7296
" "	Chromic Acid		4
" "	"		16 6676
" "	"		328.
" "	"		
" "	"		
" "	"		
" "	Bichromate of Potash		
" "	"		
" "	"		
" "	"		
" "	Bichloride Tin		

At Intervals of minute.

Coarse Oil				Fine Oil				After 5 Consumption Coarse	Fine
33	48	26, 52		2052		1328		2146	737
65	1111			34		32		34	22
				8208		2656		5544	14 54
				156		39 84		35 1	32 64
	2222			9764		4 2496		2964	32
	3333			4 1 1 1		24		32	18 6112
	35 5552			4 6 5 5	33	9964		1 6228	4 5
	26				24	4972	109	44	181 4592
	2844				3 3 7 4	6 1 5 5			109 4
	24 1 1 4 4		476		101				0 9 2 6
	27 7 3 0 5 5		4		227				
	104 4 4		49 7 8 4		209 1				7296
	167 5 6		314.						4
	144								36 4 8 20
	18		2 4		7296				15
	160				2 8 8 8	7296			65
	1036				6				32
	32		4	1 0 4 4 4	3 4 4 8				130
	3 1 0 8			2 7 5	12				115
	3 1 0 8								208
		2472							98
		3 1 0 8							16 64
		33 1 2 2			7296				14 5
		98			4				162 4
		2652 16			16 6676				109 4
		23 2064			166				52
		2 8 8 5 5 5 16							
		109 44			7296				
					4				
	149 114	2		5 7 0 7 4 8					
				255					

At intervals of minutes

Bases	Oxidizers	P. Electrode	N. Electrode	Coarse Coil			Fine Coil				After Stoppage	
Nitrate Ammonia	Bichloride Iron										Coarse	Fine
" "	"				63	701	2	1328		1336	62.32	4.55
" "	"				35	754					1.895	1.429
" "	"					37		53	26.	57	34	33
" "	"				1.964						7.326	
" "	"				34	.498					1.615	2.58
" "	"				32	32					.07390	4.67
" "	Bioxide Iron		17		7.066	2.76			61336		.09205	47.26
" "	"		1.600		27				32			36.5524
" "	"		1.677		5.896	1.46.6			60.8752		6.2	1.320096
" "	"		100			26			32		3.2566	7.72
" "	"		6716		5.896	2.2.9.25			7.5.7.6		3.2095	
" "	"		669		10.9.7.2				6.6.4.8		12.1.0.2.6.6	
" "	"		1		13.1.1.0.4.8				6.4.0.7.7		1.1.1.0.6	
" "	"				100.16				3.1.4.4.1		.0004	
" "	"		2		2.7	8			.0.7.3.3			
" "	"		6677		66		6667				2	
" "	"		3.3.7.5								7	
" "	Bioxide Iron				1.6667		0.6.7		1.1.6		16	
" "	"				.111						14	0.6.6.0
" "	Permanganate Potash	4 Ohm	67.			7.3.3.9			2.2.2.1		15	32.0.6
" "	"					12.2			2.0.0.5		.09	1.16
" "	"								2.0.0.5		0	
" "	"		1.336						2.0.4.4.1		0	
" "	"		32						2.0.0.5.6.4			
" "	"		2.4.7.0						2.0.0.5			
" "	"		3.7.0		6.6.7				1.7.3.0.7			
" "	Carbolic Acid				6.0.7.3				1.6.6.1			
" "	"		3.9.5.7.8		.3.-				.7.7.4.6			
" "	"								.6.6			
" "	"		3.4.6.4.1.6		1.3.2.8				0.6.6.7.7	0.6.6.7.7		7.3.2
" "	"		3.7.6.5.6.4		32				0.6.6.7.7	3.4.7.7		32
" "	"		3.0.5.0.6.6		2.6.6				4.9	185		1.5.0.5
" "	"		100		3.9.4.4							26.2
" "	"		20		4.8.4.1.6.7							4.1.2.5
" "	"											7.5
" "	"						0.6.6.7.3				19	3.0.2.4
" "	Sulphuret of Potassium		3		3.0.9.7.2						1.6.1.5.9.6	
" "	"				2.9.9.1.6.8.8		6.0.9.3		1.7.4		0.8.1.9.5.4	
" "	"				1.0.8.1.4						6.6.7	
" "	"				1.0.0.7			1.4.7.5			1.6	
" "	"				2.0.7	3.4		3.3.2.8.6				

Bases	Oxidizers	P Electrode	N Electrode
Nitrate Ammonia	Red Lead	1.192	
" "	"	32	
" "	"	2.3814	
" "	"	3576	
" "	"	3.81444	
" "	"	19073	
" "	"	.0572.16	3.5144
" "	"	75	75
Water Glass.	Peroxide Lead	4.5772	3.4152
" "	"	40081.2	2.6005
" "	"	44.4284	2.9642.32
" "	"	12	12525
" "	"		17127
" "	"	0.835	
" "	"	2	
" "	Peroxide of Manganese	1.8745	
" "	"	296	
" "	"	1.882	.933
" "	"	32	32
" "	"	7.5525	1.866
" "	"	5.646	.1799
" "	"	6.3955	2.9556
" "	Chlorate Potash	3.994	75
" "	"	.09595	2.35848
" "	"		2.8992
" "	"	.0639	2.32575
" "	"	2	.09595
" "	"	.44976	1.3650
" "	"	7.24.	
" "	Nitre		
" "	"		
" "	"		
" "	"		
" "	"		

All Intervals of minutes

Coarse Coil	Fine Coil	After 5 Coincidences Coarse	After 5 Coincidences Fine
1.429	.701	1.964	1.601
34	32	34	32
5.716	1.402	7.856	3.202
42.87	2.103	8.992	4.803
48.586	2.432	.06676	1.2052
2.493	75	.93365	75
.07.2579	.2.994.56	.10016	4.09716
	1.5702.4	.0.4835	3.57264
	1.7496.96	2	3.99756
	07.87	3.4006	100
	102.08	17.	2.990
			0.667
			0.669
2.75	.010.32		4.0062
64	75		
1.00	3.46	0.835	
72.5	2.3.4	3	
0.03.350	.2.5.96	2.505	
12.2	12.2		
4.175	13.79		
.12.525			0.6398
1.882	.701		0.6398
24	32		0.6398
7.525	1.402		4.6378
5.646	2.103		
0.63955	2.432		0.639
2.994	75		0.639
.09.5952	1.794.56		7.029
	1.7702.4		176
	1.7496.96		
	09.87		
	7.90.		
	6.3		
	15.		
	75		

Bases	Oxidizers	P Electrode	N Electrode
Water Glass	Nitric		
"	Chromic Acid		
"	"	56	46
"	"	1.483	0032
"	"	0594	78
"	"	5932	24
"	"	4449	234
"	Bichromate of Potash	050422	.2498
"	"	02521 1	0756
"	"	07563 3	.7330
"	"		3/12
"	"		150
"	"		35
"	"		0504
"	"		5541 10
"	Bichloride Tin		
"	"	52	35
"	"	1.251	.741
"	"	34	32
"	"	5524	1432
"	"	3843	2023
"	"	4355 4	2232
"	Bioxide Iron	2177	78
"	"	1797	1797
"	"	0532	1596 24
"	"		.1749 796
"	"		0653 2
"	"		10964
"	"	2/12	4355
"	Permanganate of Potash		4
"	"		7420

At Intervals of minutes -

Coarse Coil			Fine Coil			After 5 Circuit 2m Coarse	Fine
70	2.75						
56	1.483			2.75		1483	
				037		37	
				1925			
				125		1031	
				1075		4449	
				50			
				87		00	4871
				1526			78
						4359	65
			10475			3840	97
			00548				
			0	3 ohm		4279	938
			0427			1526	
	10775						
	9					2753	
	91875					096	
		14578		2.607			1964
				037			37
				1829			
69	2.607			78		1354	8
63	1.964	5 ohm		0964		589	2
65	2.146			59			
61	1.805			1446		00744	68
				8			78
				096459			
					1.59	5744	
			096459				
			00744		1061049	2	276
		074402					
		7		0890	2	8050	8
						85	04
						0	685
						0	648
						4	4
				2.146		6270	2
				33		63	162
				1.805			
				38		1.89	1805
							37
			074402				2639
			00744				5415
			0794			00	6785
			3910	3727	24		78
			1910				
			4006			53	2250
			072			467	495
						5	250

Bases	Oxidizers	P. Electrode	N. Electrode
Water Glass	Bimanganate of Potash		
" "	Carbolic Acid	1.338	.488
" "	"	.5312	.9795
" "	"	.39844	.14644
" "	"	.045252	.156616
" "	"	.22626	.06888
" "	"	.067888	.057258
" "	"		
" "	Sulphuret of Potassium	.045255	
" "	"	.31675	
" "	"	.158	
" "	"	2.477	.839
" "	"	.03 4	.36
" "	"	.9908	.7677
" "	"	.7931	.6548
" "	"	.7918	.7622
" "	Red lead	.05 4 2 1 9	1.4 2 1 6
" "	"	4 2 1 0 9	
" "	"	.13 6 3 2 7	.34
" "	"	.2105	.16
" "	"	0.8842 18	
" "	"	1 (.35 2 6 5 4 / .84 6 1 8)	
Caustic Soda.	Peroxide lead	1 (.5 / .8 4 6 1 8)	
" "	"	.1094 8 3 3 / .274	
" "	"		
" "	"		
" "	"		
" "	Peroxide of Manganese		

Abstract of minute

Coarse Coil			Fine Coil			After Short Circuit 2m.	
						Coarse	Fine
59	1.665	1665		578	0.5604		
30	.578	.34		.32	.15		
35	.78	660		.156	.2830		
35	.709	4 4 9 5		.1734	.141		
		0.5 6 6 1		.18 4 9 5			
		.2530		.38			
		0.5 4 9 1		.14 7 7 6 5	.711		
				.32			
		.78		.13 4 9 7 2	.1402		
		.32		.14 4 2 6 5 5	.2103		
		.15 6 4		0.5 4 1 9	.2 2 4 3 3		
		.3 4 6			.76		
		.2 5 0 2 7 4		0.5 7 3	.1794 5 6		
		.7 5			.15 7 0 2 4		
		.2		0.5661	.17 4 9 7 9 5		
		.20 0 1 9		.3	.0 8 4 9		
		.17 5 1 6		.16 9 8 3	.0900 7		
		.19 5 1 8					
		0.0 4 9 1				1.601	
		.7 0 2 7				.34	
				0.5664		6 4 0 4	
				.9		.8 0 3	
				.1 5 7 9		0.5 4 0 2 7 4	
				.195	.625	.32 2 7 7	
					.32	0.1 6 5	
58	1.601				.1250	16 8 3	
32	.625				.1 7 5		
					.2 0 0 9		
					.78		
				16.0			
				160			
				.1560 0 0	1½		
				.0916			
				0.7 4 4			

Bases	Acidiferous	P Electrode	N Electrode
Caustic Soda	Precipitated Manganese		
"	"		
"	Chlorate Potash		
"	"		
"	"		
"	"		
"	"		
"	Nitre		
"	"		
"	"		
"	"		
"	Chromic Acid		
"	"		
"	"		
"	"		
"	Bichromate of Potash		
"	"		
"	"		
"	"		
"	Bichloride Tin		

A Intervals of minute

Coarse Coil				Fine Coil				After S Circuit 2m. Coarse	Fine
50	1.192	53	1.328						
46	1.036	50	1.192						
							1036		
							.0037		
						1192	7252		
						37	3108		
					53	24			
	1.192 × 037 = 0.044104				3576	0.03833 2			
	1.036 × 0037 = 0.03833 2				44104	7 8			
					22052	3665 6			
					66156	261324			
						29198 96			
	044104					066 156			
		13				2 3 0 5 3 3 6		= John.	
2	5636	52				044104			
	3816	76							
			1.328				1192		
			37				37		
		9296				5544			
	3984				3576				
049	13	6			00441	104			
	24	568				78			
				3 5 2 5	32				
73	704			3 0 5 7	28				
				3 4 4 0 1	13				
				0 7 3 7	04				
				2 7 0 3 0 7	2	=		5½	
049	13	6							
		7		049	13	6			
3m	3 9 5	2							

Bases		Oxidizers	P Electrode	N Electrode	At Intervals of minute: Coarse Coil				Fine Coil				After Saturation: Coarse	Fine
Caustic Soda		Bichloride Tin												
"	"	"				1.325		4711			1601		4337	
"	"	"				32		24			32		24	
"	"	"				26		18844			3202		17345	
"	"	Bioxide Iron				3984	14235				4803		16011	
"	"					42496	160174				6723		17345	
"	"	"				48	14087				27		37209	
"	"	"			33	9968	24026				40456		21187	
"	"	"			19	7472					35524			
"	"	"			33	14658					39660		1/4	
"	"	"			24	6026		32			23159			
"	"	"			9	120					17422		14764	
"	"	Permanganate of Potash			16	07.					1474.		14745	
"	"												4 6219	
"	"	"					1.805						405	
"	"	"					72							
"	"	"					5415				782		1882	
"	"	"					61370				22		24	
"	"	Carbolic Acid					36				5624		5225	
"	"	"					9205				2346		5646	
"	"	"									2502		6 9958	
"	"	"					675				71		3 1994	
"	"	"					13				20019		9 5952	
"	"	"					1350				17568			
"	"	"					3025				19587		19 94	
"	"	"					214				958			
"	"	Sulphuret of Potassium					71				9920			
"	"	"					1710				13.			
"	"	"					1498							
"	"	"					1169					4437		
"	"	"					920					6437		
"	"	"					749					1950		
"	"	"					45.	1/4				4 194		

Basis	Oxidizers	P Electrode	N Electrode
Caustic Soda	Red Lead		
" "	" "		
" "	" "		
" "	" "		
" "	" "		
" "	" "		

60 1.733 × 037
46

1733
037
12131
5199
0641 21
32 06
0961 81

0641 21
00 3833
0602 88

2989896
0961 81
2028 08

0602 88

2 3½ × 1½ × 0641 21 = 32 06 05

364
037
25448
1092
0134 68
0673 44
0202 02

20 364 × 037 = 0134 68
10 177 × 037

177
037
1239
531
0065 49
79
5239 2
4584 3
051082 2
026 20 6
0312 801 = 2p
0173

0134
0006

At intervals of minutes

Coarse Coil			Fine Coil			After S Circuit 2m. Coarse	Fine

55 1.429
46 1.036

1.429
037
10003
4287
052873
26436
0793 10

1036
037
7252
3108
0038332
3066 76
2683 24
2989896
0793 1
3196796
052873

0538
0332
496

2 4 ohm.

052873
11
581603
2958

29

45.1 · 2037
41.9

037
0032
030

037/3
481
1405

6 ohm

6g 2.607
55 1.429.

50 1.192.
55.

0037
6687
2611
0032719
78
2558 52
2253
2510 53
65
201042
033

2607
087
18249
7821
096459
48229
144688

096459
0052
0912

1.192
037
8344
3576
044104
2305
066156

044104
0052
8388

9.

044104
14
3969 36
441104
8 3 7 9 7 6
2 1 8 9.

3 ohm

096459
8 8 1 8 1
4324
412097
144688
267410
0912.

412097.
066156
345941
0388. 9

Resistance ... Ohm

Co 56 41 Co
46 41

6 1.805.
55 1.429
a 10 58

1805
037
12635
5415
066785
33592
100177

1429
0037
10003
4283
0052833
78
42266 4
369831
412097 4

066785
0052
0615

312097 4 = 5 ohm
0615

066785
13
1 066105
37 7534
33 65

037890
13
36 2674
6 ohm .8133

264
037
3277
2266
027896
1394
04188
01 2 40
01 65 35
18759
0418
14579
0254

02789
0034
254

30 1.192 ×037
25 .467

1.192
37
8344
3576
044104
220 57
.066156

467
78
3269
1401
0077279
1352232
1209553
1347762
066156
0686202
042377

042377
7
.132212

66 42.348
42 901
43 933

933
637
6537
2799
083776

901
037
6307
2703
083776
6155
003337
1247124

348
037
936
1044
083776
003521
78
2403333
276168
7974
2692638
1247124
1445
797

266696
233359
2600286
1247124
1352646
797
2ohm

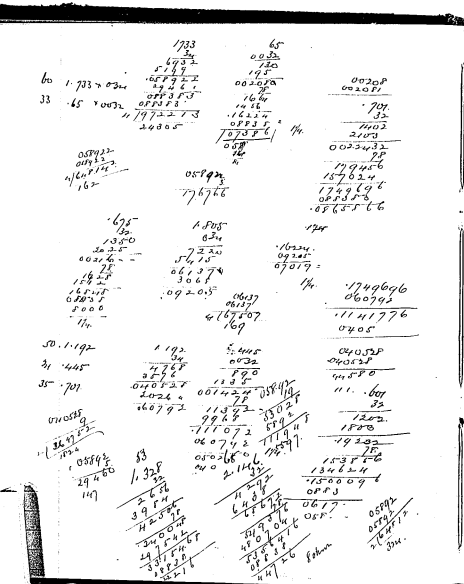
Coffin

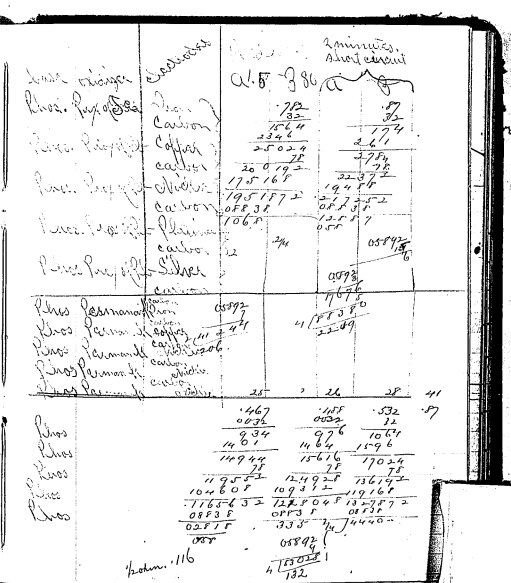
Unscaled railroad Coffey + Carson	26	3 / 46	9 / 13	
Pb. railroad Shoup + Pais	70	54	58	40
Pb. railroad Elmore + Camp	37	31	45	34
Pb. railroad Stat	0	0	0	
Phosphate railroad Alvord + Carson	32	23	32	20

78 44.711
58 1.601
75 3.736
037
261552
11208
1382232
69111
207 3345 / 30 / 5
1280149
610

4711
037
32977
14137
1743307
89153
26656
2ohm
1382232
005923
132309
1382232
7
9676624
1068m

1601
037
11207
4808
0069237
78
493896
4146559
4614486
207 324
20 060
4 ohm
2537
1323




2 minutes.
Aliot circuit
W.B. 386
Cartons
Coffee
Silver
Cartons
Cartons
Silver
Cartons
Cartons
Cartons

March 5. 1888.

Chloride of K. 50
Caustic Ala 50

		a	b	
(1)	Sulphate	15	58	Pb – C +
	" "	16	9	Ag – C +
	" "	10	17	Ag – C +
	Low red.	54	56	Pb – C +
	"	59	62	" "
	"	64	65	" "
	"	63	65	"
	"	64	66	8 ohms = .7307780 volt
	Red	61	46	
		53	33	
	Nitrite	50	29	Pb – C +
	Sup red	3	4	Pb + C –
	"	20	19	Sb + C –
	"	12	37	Hg – C +
		9	14	Cu – C +

This mixture cracks the crucible

64 2.052 + .037 = .0769 24
66 2.248 + .0037 = .0083176

$$r = \frac{78 + .0083176 - 1.5 \times .0769 24}{.0769 24 - .0083176} = \frac{.5333868}{.0686064} = 8 \text{ ohms.}$$

$$.0769 24 \times (8 + 1\tfrac{1}{2}) = .730778 \text{ volt.}$$

(2)
March 5. 88
Sulphate Sup red 60 Pb
Phosphoric Acid 40 Pb

a	b	
		Pb + C – red
		Inside Pb + C –
14	14	
13	19	Hg + C – Red.

(3)

a	b	
5	7	Pb – C +

Nitrate Sup red 50
Nitrate Red

(4)
Phosphoric Acid 30
Sulphate Ala 70
~~Sulphate 130~~
Will yield most at any heat.
Red. 0.0.

N.B.

March 5. 1888

Alum Sulphate 30 Phosphoric acid 40 (5)

Al + C−	21	45
Cu + C−	24	42
Ni + C−	16	48
Zn + C−	50	61
Pt − C+	7	23

When first heated quite ~~red~~ Magnesia
At red heat a bluish Sp. grav. mass

Nitrate K. 60 (6)

	a	β	
Hydrate alu 40 Sweet	80	66	Pt − C+

80 . 5.681 × .037 = .210197
66 . 2.248 × .0037 .0083176

$$\frac{.0083176 \times 78 - 1.5 \times .210197}{.210197 - .0083176} = \frac{3334778}{2018794} = 1\tfrac{1}{2}\text{ atm.}$$

$$.210197 \times (1\tfrac{1}{2} + 1\tfrac{1}{2}) = .630591$$

(7)

March 5 1888

Nitrate of K. 100 Cas. any Platinum −

	α	β
	5	40

Cannot fuse at a low heat burnt with some frizzy and an odor

(8)

Na. Nitrate ½ — α β
Nitrate K ½ (½ sweet) 3 10 Pt + C −

(9)

Mixture cannot fuse burning with a deflagration

Plumbago	25	10	10 Pt − C −
Dana	25		
Nitrate K	25		

Would not liquify

March 6. 1888

1

Try same Caustic Soda

Boracic Acid 60
Sulphate of Lime 40 Nothing at
Arty Invest. no current.
tried small quantity of sulphate lime with chloride zinc as a base
some results

2

~~Sulphur~~
Pure Lime of Iced 75
Caustic Soda 25
Metals at red heat.

Mg	0	3	Platinum
	0	6	Dirt Cu
	13	7	Cu – Cat +
	33	26	Ni + C –
	70	56	Ag – Ct +

3 4 3 ohm 4 volt

---

becomes like molten lead at red heat

		a	B	3
Silver –	Carbon +	9	9	
Copper +	Carbon	6	6	
Nickel +	Carbon	40	22	
Iron +	Carbon –	0	0	
Platinum –	Carbon +	18	8	

Sulphate Lead 50%
Caustic Soda 50 %

March 6 1888

4

Boracic Acid 70
Sulphate of Lime 30 very red.

	a	B
	0	0 C+ Pt-1

Would not melt

5

Sulphate of Lime 25
Phosphoric acid 75 a quiet mixture

	a	3	
Pt –	28	35	Low.
Pt –	25	52	Red.
Cat.	6	34	Red.
Ni +	34	48	Red.
Ni +	21	34	Red.
Cu +	28	30	Red.
Pt –	11	29	White
Pt –	10	25	White
	10	35	White

More sulphate of lime added to
matter at 33%
More sulphate of lime added to matter at 50% of lime

6

Sulphur 20
Plumbago 20
Phosphoric acid 60 Pt –

a	B	
5	6	Low Red
5	9	White

March 6. 1888

Sulphate Soda 75
Nitrate of Iron 25

	A	B	
Red	18	21	Pt – C +
Bright red	30	45	
" "	35	30	
White	24	25	

Borax 50
Sulphate 50

	A	B	
Red	23	11	Pt – C +
White	66	42	Pt – C +
	38	21	

Borax 50
Sulphate Soda 50

	A	B	
	66	43	Pt – C +
	36	25	Red
	46	31	White
	23	10	"

March 6 1888

Borax 50
Sulphate Soda 50
Nitrate K 50

	A	B	
	1	2	Platinum +
	5	8	Carbon +

Liquid allowed to evaporate before it could be fired.

March 7th 1888

Borax 50
Sulphate Soda 50
Nitrate K 50

	A	B	
	5	15	Platinum – C +
	10	11	Ag + C –
	29	25	Cu + C –
Mixture same liquid	63	55	Sr + C –
a Nova Scotia sort	3	3	Ni + C –
	~~40~~	~~15~~	Plat – Car +
	40	28	White Pt – C +
	5	3	Ag – C + White

		A	B	
Boracic Acid 33⅓	red Scot	20	8	Platinum – C +
Chaguvina 33⅓	" "	16	15	Cu + C +
Caustic Soda 33⅓		5	8	Cu – C +
	Red.	20	12	Ag – C +
		56	33	Sr + C –
		5	6	Ni – C +
	White	4	3	

March 7 1888

		a	b	
Boracic Acid 33½				
Sulphate Lime 33½	Liquid	10	10	Pt – Ct
Caustic Soda 33½	Red	35	15	Pt – Ct
	"	31	1	Ag + C –
	"	35	21	Cu – Ct
	"	50	25	Cu – Ct
	"	43	12	Fe + C –
	"	13	5	Ni – C –
	White	25	15	Pt – Ct

Body
Liquid red

Sulphate of Strontia 50 Soda 50 — a 24, b 99 — Pt – Ct +
2 ohms = + EMF. 1678616 – 50 | 30 Cu – Ct +
25 | 20 Ag – Ct +
55 | 41 Fe + C –
2 | 6 Ni + Ct +

Melted at red heat
Cooling as thick as
Castor oil

March 7 1888

Sulph. Strontia 70	Red	0	10	Platinum – Ct +
Borax 80	Red	39	40	Copper – Ct

Sulphate Soda 50% — 55 31 Copper – Carbon +
Borax 50% — 50 38
55
35
55

Sulphate Soda 50 — a 19, b 20 — Ag – Carbon +
Borax 50 — 7 0 0 Ag 0 " 0
10 4 Ni +

Soda Sulphate 33⅓ — 8 a b
Borax 33⅓ — 8 8
Caustic Soda 33⅓ — 16.9 Copper
26 16 Plat – Ct +
25 11 Copper – Ct +
0 1 Ag – Ct +
54 35 Pb + Ct +
20 6 Ni + Ct –
15 15 Plat – Ct +
27 23 Copper –

33 25 Copper –
40 29
43 33
42 22
40 22

Tan[illegible] Table.

No	Tan	No	Tan	No	Tan	No	Tan
1	.017	34	.445	47	1.072	70	2.75
2	.035	25	.467	48	1.111	71	2.907
3	.052	26	.488	49	1.151	72	3.081
4	.07	27	.510	50	1.192	73	3.274
5	.088	28	.532	51	1.236	74	3.487
6	.105	29	.555	52	1.281	75	3.736
7	.123	30	.578	53	1.328	76	4.016
8	.141	31	.601	54	1.377	77	4.337
9	.159	32	.625	55	1.429	78	4.711
10	.177	33	.650	56	1.483	79	5.152
11	.195	34	.675	57	1.541	80	5.671
12	.213	35	.701	58	1.601	81	6.314
13	.231	36	.727	59	1.665	82	7.120
14	.250	37	.754	60	1.732	83	8.144
15	.268	38	.782	61	1.805	84	9.514
16	.287	39	.810	62	1.882	85	11.43
17	.306	40	.839	63	1.963	86	14.301
18	.325	41	.870	64	2.050	87	19.081
19	.345	42	.901	65	2.146	88	28.636
20	.364	43	.933	66	2.246	89	57.29
21	.384	44	.966	67	2.356	90	Inf.
22	.404	45	1.	68	2.475		
23	.425	46	1.036	69	2.605		

$80°$ on $a = 5.681 \times .04 = .22724$.

$73°$ on $B = 3.274 \times .00356 = .01165544$

$$r = \frac{78 \times .01165544 - 1.5 \times .22724}{.22724 - .01165544} = \frac{.09912432 - .34086}{.22724 - .01165544} =$$

$$\frac{.56826432}{.21558456} = 2.6 \text{ ohms.}$$

$x = .22724 \times 2.6 + .34086 = .931754$

28th February 88

Constant of sine tangent galvanometer.

$\frac{0.6240}{14.5415} = 0.04$ gives unit deflection $\therefore C = 0.04 \times \tan m^\circ$

$\frac{0.6140}{88.5478} = 0.0038$ gives - - $\therefore C = 0.0038 \times \tan m^\circ$

15 . 268 × .07 = .01072

27 . 7547 × .0038 = .0028652

$$r = \frac{78 \times .0028652 - (1.5 \times .01072)}{.01072 - .0028652} = \frac{.2234856 - .01608}{.0078548} =$$

$$\frac{.2074056}{.0078548} = 27\tfrac{2}{3} \text{ ohms}$$

$$x = .01072 \times 27\tfrac{2}{3} + 1.5 \times .01072 =$$

$$x = \frac{.01072 \times 175}{6} = .3143 \text{ volts}$$

54 . 1.377 × .04 = .05508

40 . .839 × .0038 = .0031882

$$r = \frac{78 \times .0031882 - 1.5 \times .05508}{.05508 - .0031882} = \frac{.2486796 - .08262}{.0518918}$$

$$\therefore r = \frac{.1660534}{.0518918} = 3 \text{ ohms}$$

$$x = .05508 \times 3 + 1.5 \times .05508 = \frac{.02754}{\cancel{.05508}} \times 9 \quad .24786$$

$\therefore x = .24786$ volts.

a 74 3.481 × .04 = .13924
B 69 2.607 × .0038 = .00990660

~~a 76 4.016 × .04 = .16064~~
~~b 56 1.488 × .0038 = .00563584~~

$$r = \frac{.78 \times .00990660 - 1.5 \times .13924}{.13924 - .00990660} = \frac{.77[illegible] - .20886}{.12933334} =$$

$$= \frac{.56588018}{.12933334} = 4\tfrac{1}{3}\text{ohms}$$

$$x = .13924 \times 4\tfrac{1}{3} + 1.5 \times .13924 =$$

$$x = .13924 \times (4\tfrac{1}{3} + 1.5) = .13924 \times \tfrac{35}{6} = \frac{.13924 \times 35}{6} = .81223\text{ volts}$$

a 76 4.016 × .04 = .16064
b 56 1.488 × .0038 = .00563584

$$r = \frac{.78 \times .00563584 - 1.5 \times .16064}{.16064 - .00563584} = \frac{.43856112 - .24096}{.15500046} =$$

$$r = \frac{.1976012}{.15500046} = 1\tfrac{1}{3}\text{ohm}$$

$$x = .16060 \times 1\tfrac{1}{3} + 1.5 \times .16060 = \frac{.16060 \times 17}{6} = .45503\text{ volts}$$

Pt — Carbon

Sodium Sulphate 15
Boracid 2

	Ca	Cb		
		16		
Rod	3	15		
	~~3~~	26		
Blood Red	10	46	Bubbles	
Albumen	34	48	Std Res	8 m.f
Mute	74	69	4 1/3 ohms	.81223 volts
	76	56	1 1/3 ohms	.45503 volts

When first mixed very liquid. When at 60° Rod cons. into sponge.

Ag – Carbon +

Soda Sulphate 75
Boracic acid 25

	a	b
White	30	25

	a	b	
Mint + Carbon	52	29	Red

Soda Sulphate 75 Boracic Acid

	a	b
Red White	20	16

Cu + Carbon + Soda Sulphate 75
Boracic acid 25

	a	3
Drop + Carbon – Red	40	23

Boracic Acid Soda Sulphate

40 Sulphate of Zinc
40 Sulphate of Copper } did not mix well
10 Boracic Acid

	a	b	
Red Scarlet	1	5	Pt – Ct
Bright Red Scarlet	10	38	
" " "	15	35	
White	15	31	Ths Int 27 ⅓ Ebn 7 · 3143 vocb.

	a	b	
Sulphate of Zinc	40		Ag –
" " Copper	10		C +
Boracic Acid			

	a	b
Red Scarlet	1	11
Bright Red		
" "		
White		

000047

ag-C+

	a	B
White	0	7

Sulphate of Zinc } 40
Copper
Boracic Acid 10

---

	a	B
White	2	7

Ni+
C−

Copper Sulphate } 40
Zinc
Boracic Acid

---

	a	B
White	0	3

Sic−
C+

Copper Sulphate } 40
Zinc
Boric Acid 10

Sug. Soda 75
Phosphoric acid 25

	a	B
low red	10	10
low red	44	40
Red	55	46
x bw R. N. White x	54	40
3 ohm 8 m.f. 124/186 volt low Red	10	6

Pt−C+

Great Chemical Co.
Mustard
Cayenne
Jamaica
Sweet

ag−C+

	a	B
low Red	40	46

Ni+C−

	a	B
low R. Red	33	31

Ni+C

	a	B
low Red	53	53

Sic+C−

Phosphorus and
Sulphide arsenic.

Pos.	Neg.		a	B.
Carbon	Flat	Dull red.	5	5
		rich	12	12

$65 = 2.146 \times .04 = .08584$

$65 = 2.146 \times .0038 = .00815548$

$t = \frac{.78 \times .00815548 - 1.5 \times .08584}{.08584 - .00815548} = \frac{.5072144}{.07768452} = 70$ ohms.

$Sm\,t = .08584 \times 7 + 1.5 \times .08584 =$

Liquid thickness of water –
bubbles – inflammable gas –

$45° = 1 \times .04 = .04$

$65 = 2.146 \times .0038 = .00815548$

$t = \frac{.78 \times .00815548 - 1.5 \times .04}{.04 + .00815548} = \frac{.5760744}{.0318452} = 19$ ohms

$Sm\,t = .04 \times 19 + 1.5 \times .04 = .04 \times \frac{19.5}{1.5} = .78$ ohm –

Wednesday 24th Feby 1888

Sulph. Acid 60 ~ 20

Boracic 40

a	B		a	B
Very red 5	25	Lowest 5	23	
3	17	Very Red 6	21	
3	17		31	
White 3	14	White 20	45	

$t - Rt$

~~Red~~ a 3 / 3 3

Ag – Carbon +

Soda Sulphate 60 ~ 20
Boracic Acid 40 ~ 20

Boracic Acid 10
Soda Sulph. ate 90 cm

a	B	
4	22	Red
21	18	
4	33	Very Red
21	56	White
45	95	White

Rt – Ct

Boricac acid 10
Soda Sulphate 90

	a	B	Red	Sheet
	10	63		
	43	52	Ni + C −	
Inverted	20	25	Ag + C −	
	90	59	Ag + C −	
	dull 10	25	Cu − Cu +	

Mixture of Acid
Sand 25
Soda Sulphate 90
Boricacid ×

	0	66	Red Cu −
	66	66	Red Sulphur
	70	59	Mixture Cu −
a	2		
low red	8	36	Ag − C +
low red	20	23	Ni + C −
low Red	20	26	Cu − C +
	11	33	43 Fe + C −

× Int Res 3½ ohms E.M.F. .5219 volt.

70 2.607 × .04 = .10428
89 1.665 × .0038 = .0063274

$$r = \frac{78 \times .0063274 - 1.5 \times .10428}{.10428 - .0063274} = \frac{.337086}{.09795} = 3\tfrac{1}{2} \text{ ohms}$$

$$x = 10438 \times 3\tfrac{1}{2} + 1.5 \times 10438 = .10438 \times 5 = .5219 \text{ volts}$$

20 = .364 × .04 = .01456
45 = 1 × .0038 = .0038

$$r = \frac{78 \times .0038 - 1.5 \times .01456}{.01456 - .0038} = \frac{.27456}{.01076} = 27 \text{ ohms}$$

.01456 × 27 + 1½ = E.M.F. = .41496 volt.

38 .78 × .04 = .03128
26 .488 × .0038 = .0018544

$$r = \frac{78 \times .0018544 - 1.5 \times .03128}{.03128 - .0018544} = \frac{.047232}{.024256} = 3 \text{ ohms}$$

.03128 × 3 + 1½ = .14076 volt

Pt — Ct

Sand 20
Sodium Sulphate 75
Borax acid 5

Boracic Acid at Red

a	3
4	28 Red low
14	45
23	51 Dull Red
26	55
65	65 ohms .72964
60	68?
53	35

Sulphide of Potash 21
Sulphide of Soda 7

a	3
8	10
7	27
~~28~~ 28	38
38	24

Sulphide Potash 99%		38	26
2 crystals Boric Acid			
does not melt until			
White heat then gives off			
Sulphuretted Hydrogen in small quantities			

65 = 2.146 × .04 = .08564
65 = 2.146 × .0088 = .0081548

$$T = \frac{.79 + .0081548 - 1.5 \times .08564}{.08564 - .0081548} = \frac{.5073144}{.0776852} = 7 \text{ ohms}$$

$$.08564 \times 7 + 1/2 = \frac{.04282}{.08564} \times \frac{17}{2} = .72964 \text{ ohms}$$

250 m a = .467 × .04 = .01868

550 m B = 1.429 × .00256 = .00508724

$$\frac{78 \times .00508724 - (1.5 \times .01868)}{.01868 - .00508724} = x = \frac{.3968574472 - .02502}{.01359276}$$

.3968574472
.02502
.3687847472 (x
27185852
.3687847472

.01359276) 27 ohms

$$x = .01868 \times 27 + (1.5 \times .01868) = .01868 \times 27 + .02502 = .5472$$

76 55.
55

1/4

79 | 5.152 × .034 = .175168
58 | 1.609 × .0032

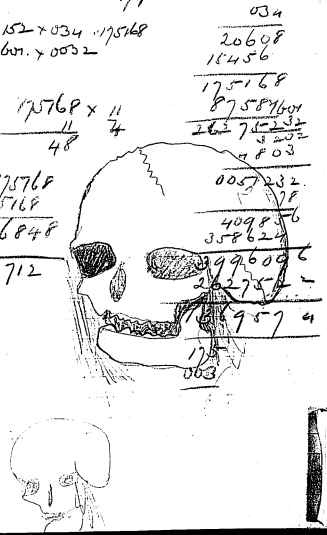
.175168 × 11/4
11
48

175168
175168
4 | .1426848
.481712

5.152
.034
20608
15456
.175168

87584604
2623 752 32
3 200 2
7803

.0057232
78
40985 6
358624
3996096
2627584
1669574
175
003



79 5-152.
84 9.541

5-152
04
.20608
18304
30912
03972
.27192

9.541
0039
85869
28623
037209 9
78
29767972
26046 93
200237 22
27192
26603 5 22 (2
20608
56955
41216
15739 2
14425 6
13136

123 14
1 1/2
12
4 14

.20608
57
14425 6
10304 0
12416 6
12 4698

47 14
.18845
31908
94220
4 107410 8
2 6

a 12
54 48
1371 1111

3.736
4
.4944
7472
22416

14944 3
54832
7472
52304

2.082
4
08328
4167
12492 68

35. 3.736
60 1.783

1783
31
55597
5199
67578
540696
473109
5277786
22416
14944 30301 86 (2
29

52775
12492
40225 86 (5

08328
49969
4167
41132

March 1. 88.

Caustic Soda 25
Lead 25
Cu Sulphate 25
Red Lead 25

Base Pt — C+

	a	b
Lt red	35	43
Red	60	50 x
Light red	53	47
" "	58	36
White	8	11

Acid Silica condensa Mich.
Silica Molasses & white

#1

+ 4 ohms · 38126 volts –

#2

Phosphoric acid 20
Lactic acid 20 liq
Oxalic acid 10 x red
Acid Ammonium oxalate 20

	a	b	
	25	35	C – P+
red	25	22	C+ P+ –
	24	30	Red
	31	41	Very red
	31	40 x	

= 10 ohm · 27623 volts –

Great chemical action on heating treated. Very fused at low heat

000054

Pt – C +

Boracic Acid 20 — BO_3

Soda Sulphate 20 — $Na_2O.SO_3 + 8 H_2O$

Transition Temperature 22.5 0.50

	a	b
Vapor	4	11
	3	25
White	10	46
	3	20
	3	20

Middle of high heat

Vapor Ag could not be tested as mixture hardened at melting point of Ag

---

Soda Sulphate 20 — 33

Sulphur — 9

Boracic Acid — 33

Bichromate of Potash — 16

Oxalic Acid — 9

Would not melt at any heat

(Some Sol. in water)

#5

Pt – C +

#4 25 grams

Sulphate of Zinc 75

	a	b	
	43	51	Stained
	41	59	
	55	55	
	50	62	White +
	10	45	
	20	44	

+ 12 ohms - 64368 volt

March 2nd 1888

melted at red heat. Liquid like castor oil

Natrium Molybdate 25 gr

Strontia Sulphate 75 gr

	a	b	
red heat	25	55	
very red	70	63	4 ohms - .605 volt
2nd " "	73	60	
White	63	50	
2nd "	55	46	
3rd "	20	15	

Natrium Molybdate (pt 100) Will not melt at any
Sulphate Strontia 90% heat

Sulphate Strontia 20%
Sulphuret Antimony 40%
Natrium Molybdate 40%

	+	−	A.	B.
Pt	Pt	Electrode away	Pt. Carbon	30	20
	Pt		Carbon	40	25

20 Boracic Ac Sulphate 5 Strontia

		A	B
Pt −	Car +	Very red	3	8
		Very red	8	9
		Very red	0	11
		White	1	12
		White	2	12

When in white hot tube glass

	a	3	Pt − C +
Very red	55	21	
Very red	35	15	
White	47	29	

Chromic acid 20
Caustic Soda 80

2½ ohms
·17168 volt.

Boracic Acid 50	Pt + C −	5.16 deoxid
Morphoxin 25	C + P −	15.21 red.
Molybdate of Soda		36.36 bright
		54.45 white
bubbles of gas at white		47.54 white
		63.48
On Sulphuret Antimony White		
	Sb + C −	5.11 deoxid
	Sb + C −	8.11
	Cu + C −	8.13
	Sb + C −	35.53
Sc Short Circuited 2 minutes		35.53 low

X 11 ohm ·5365 volt.

70 2.75 × .04 = .11
63 1.964 × .0038 = .0074632

r = 78 × .0074632 − 1.5 × .11 = .4171496 / .0025368 = 40 ohms.

.11 × 4 + 1.5 = ~~.11 × 4 × 3/2~~ .11 × 11/2 = .605 volt.

---

47 1.073 × .04 = .04292
58 1.601 × .0038 = .0060838

r = 78 × .0060838 − 1.5 × .04292 = .4101564 / .0368362 = 11 ohms.

x = .04292 × .11 × 1½ = .02146 × 25/2 = .5365 volt.

---

50 1.192 × .04 = .04768
62 1.882 × .0038 = .0071516

78 × .0071516 − 1.5 × .04768 = .4863048 / .0405284 = 12 ohm

.04768 × 12 × 1.5 = .64368 volt.

---

60 1.933 × .04 = .06932
50 1.142 × .0038 = .0045316

(78 × .0045316 − 1.5 × .06932) / (.06932 − .0045316) = r = .3494848 / .0647684 = 40 ohm

.06932 × (4 + 1½) = .06932 × 11/2 = .38126

---

31 .601 × .04 = .02404
40 .839 × .0038 = .0031882

(78 × .0031882 − 1.5 × .02404) / (.02404 − .0031882) = (.2486796 − .03603) / .0208318 = .2264496

= 10 ohm. .02402 × 10 + 1½ = .27623 volt

---

47 1.073 × .04 = .04292
29 .555 × .0038 = .0021109

r = (.0021109 × 78) − 1.5 × .04292 / (.04292 − .0021109) = .1100122 / .0270811 = ~~25 ohm~~ 2½ ohm

.04292 × 2½ + 1½ = .04292 × 4 = .17168 volt.

Saturday 3rd March 1888.

Carbic Sulphate 25
Sulphuric Acid 75
Pt – Cu

	a	B
Copper red	78	58
[illegible]	75	55
Nitrogen	76	50
Nitrogen red	65	20
Cu		

78 4.711 × 04 = ·18844
58 1.604 × ·0038 = ·0660838

$$r = \frac{78 \times 0660838 - 1.5 \times 18844}{18844 - 0660838} = \frac{1918764}{1823562} = 1 \text{ ohm.}$$

$$x = \cancel{188444 \times 1} \cdot 18844 \times 1 + 1.5 \times 18844 = \frac{\cancel{94412}\ 18844 \times 5}{2} = 47106 \text{ Volt.}$$

New constant of Galvanometer 3/3/88

$\frac{0.630}{15.5 + 1.5} = .0037$ gives unit deflection ∴ C = 0.037 × tan no

$\frac{0.630}{41.5 + 78} = 0.0037$ ∴ C = 0.0037 × tan no.

Chloride of Zinc
Carbic Acid 50

	a	B
Pt – Cu Copper heat	65	57
" "	68	62

Turned pointer round 9 turns

Ag – Cu	55	63
Cu – Cu	15	24

68 2.477 × ·037 = ·091649
62 1.852 × ·0037 = ·0696634

$$r = \frac{78 \times 0696634 - 1.5 \times 091649}{091649 - 0696634} = \frac{4056722}{0846756} = 5 \text{ ohms}$$

$$091649 \times 5 + 1\tfrac{1}{2} = 091649 \times \frac{13}{2} = \frac{1191437}{2} = 595719 \text{ Volts}$$

Chlorate of K 30
Carbonate 20

~~Pt~~ Pt-C+

Red
Red

35 22 low
34 56 low
53 61
73 61
31 9
30 15
30 20

1.505
.0037
126 38
5415
.0066785

32.274
.037
22 9 78
9822
.121138

73 3.274 × .037 = .121138
64. 1.505 × .0037 = .0066785

∴ 78 × .0066785 — 1.5 × .121138 = .339216 = .1144895
.121138 — .0066785

.121138
.0064
1211 07
.339216

.0066785
.0534280
467495
.5209230
1211 07
.339216

3 ohms.

.121138 × 3 + 1½ = .121138 × 9/2 = .1090242/2 = .5455121 ohms .1144895

liquified at Brightfield
~~Chlorate of K~~ 25 like molten lead

~~15 20~~ carbon + Pt

Carbonate Soda 25
red lead 15

A.B
45.20 lead combines with Platinum

Chlorate K 35
Bicarbonate 35
Carbonate Soda 20
Phosphoric acid

76 56
~~25 20~~
C + Pt
56

Thick pasty mass
would not melt at any heat

Caustic K 27 Pt – C+
Chlorate K 75
61 48

Caustic K 25 ~~27~~ 25 Pt – C+
Chlorate K 50 ~~45~~ 35
caustic Soda 25

Chlorate 50 15 Pt – C–
Boracacid 50 35 Ag + C–
35

76 4.016 × .037 = .148592
56 1.483 × .0037 = .0056871

$$r = \frac{.78 \times .0056871 - 1.5 \times .148592}{.148592 - .0056871} = \frac{.2207058}{.1429049} = 1\tfrac{1}{2}\text{ ohms}$$

$.148592 \times 1\tfrac{1}{2} + 1\tfrac{1}{2} = .445776$

---

61 = 1.805 × .037 = .0667785
48 1.111 × .0037 = .0041107

$$\frac{.78 \times .0041107 + 1.5 \times .0667785}{.0667785 - .0041107} = \frac{.2204576}{.0626643} = 3\tfrac{1}{2}\text{ ohms}$$

.0667785 × 5.3339 250045.
45 = 1. × .037 = .037
35 = .701. = .0259037.

$$\frac{.78 \times .0259037 - 1.5 \times .037}{.037 - .0259037} = \frac{.1468086}{.0344063} = 4\text{ ohms.}$$

$.037 \times 4 + 1\tfrac{1}{2} = .037 \times \tfrac{11}{2}$ $\frac{407}{2}$ 2035

50 1.192
23 .425

1.192
.024
4768
3576
.0405528
20264
.02664
060792

425
32
850
1275
.00136
78
1088
952
10608
060792
04529
040

040828
5
20264
10132

76 4.046 [illegible] 1/4
551.429.

1429
32
2858
4287
0045728
78
36 58 74
32009 4
35657 84
204816
15176 24
130

4046
024
16064
12048
.136544
68272
.204816

136544
11
150198 4
5
68272
2
3755.

80 5.681 × .024
60 1.733 × .0002

5681
024
22724
17043
.136344
96577
.28973 1

136344
9.
1238380
434596

1.733
.0002
3466
5199
0005 5 4 56
78
4336 4 8
38 8 1 9 2
4 3 1 5 5 6 8
2897 3 1
1418258
188

48° on a = 1.111 × ·04 = ·04444 amps current in amperes on A = ·04444 amps

35° on B = ·731 × ·00366 = ——— B = ·00249556 –

$\frac{x}{r+1.5a} = a \therefore x = a \times r + 1.5a$

$\frac{x}{r+78B} = B \therefore x = B \times r + 78B$

$0 = r(a-B) + 1.5a - 78B = 0$

$r = \frac{78B - 1.5a}{a-B} = \frac{\cdot 19465368 - \cdot 0666}{\cdot 0666 - \cdot 00249556} = \frac{\cdot 12865368}{\cdot 06410444} = 2.07$ ohms

$x = a \times r + 1.5a = \cdot 04444 \times 2.07 + (1.5 \times \cdot 04444) = \cdot 0888 + \cdot 0666 = \cdot 1554$

$\cdot 00249556$
$\quad 78$
$\cdot 01996448$
$\cdot 0174689 \cdot 2$
$\cdot 19465368$

54° on a = 1.377 × ·04 = ·05508 amperes – say C_1

62 on B = 1.882 × ·00366 = ·0066999 2 " – C_2

$\frac{x}{r+1.5a} = C_1 \therefore x = C_1 r + 1.5C_1$

$\frac{x}{r+78} = C_2 \therefore x = C_2 r + 78C_2$

$0 = r(C_1 - C_2) + 1.5C_1 - 78C_2$

$\therefore r = \frac{78C_2 - 1.5C_1}{C_1 - C_2}$

$\therefore r = \frac{78 \times \cdot 0066999 2 - (1.5 \times \cdot 05508)}{\cdot 05508 - \cdot 0066999 2} = \frac{\cdot 5229376 - \cdot 08262}{\cdot 04838008} = \frac{\cdot 4403376}{\cdot 04838008} = 9.1$ ohms

35° Sulphuric Acid
75 Strong Sulphuric

+ Cu	Iron Treat			
– Pt	Rod Treat	25	22	51 50
	Very Rod	48	35	
	Nitric	45	31	45 38

EMF = ·1554 Int res 2.1 ohms

– Ag	Nitric	10	10		
– C	Nitric melted	23	21	45	59
+ Cu	Internal res ohms	54	62	55	62
+ Cu	nitric Treat	12	4	0	0
– Car.	Cu melted				
– Car.	nitric	23	20	5	5
+ Sic.	Ni melted				

Approx. = 1.377 × .04 = .05508 amperes

48° on B. = 1.111 × .00356 = .00395516 "

$$t = \frac{78 \times .00395516 - 1.5 \times .05508}{.05508 - .00395516} = \frac{.30850248 - .08262}{.05112484} =$$

$$\frac{.22588248}{.05112484} = 4\tfrac{1}{2} \text{ ohms.}$$

$$x = .05508 \times 4.5 + .08262 = .33048 \text{ volt. EMF?}$$

Gas Coke Acid

Nathans Milfoil Oxalique

		a	3
±	Carbon Pt	Low heat	29	45
		Red heat	50	46
		Black carbon	51	49
		Bright ~~Red~~ Red	53	50
		Bright Red SO	53	48
		~~White~~	47	45
		White Int t = 4½ ohms	54	48 ✓
		White SS	55	50

Bubbles at Red heat

Base Boric Acid
Oxidizer Platinum Nitric

	a	B	
+ — Ag	7	16	White
	11	7	"
	16	16	" Short C.

Base Boric Acid.
Oxidizer Nitric.

	a	B	
+ — Ni ~~Pt C~~	25	25	white
	21	19	white short Cir.

	a	B	
Boric. Nitric	8	10	white.
	4	4	short Cir. Nitric

	a	B	
Zinc Oxalic	28	47	white
	25	43	white Short Cir

Sulphate Zinc 80%. Boracic Acid 20%

		a	B	After S.C. a	B.
Positive	Carbon				
Negative	Platinum				
	Lowered.	6.	20	21.	45
	Bright red	16	43.	14.	43
Pos N	Lowered	0	0		
Ag C	Bright —	0	0		
Nic P.	melted	0	0		
Car N		0	0		

Began to melt at low red heat. about melted [illegible]
Boils at White heat

Iron P } Car P }	Red Heat,	3-	15	1-	12-
Copper P } Car N }	Poles change during S.C.	1.	3.	1.	3

Cu N Car P.

16 · 287 + · 04 = · 01148
43 · 933 + · 0038 = · 0035454

$$r = \frac{.98 \times .0035454 - 1.5 \times .01148}{.01148 - .0035454} = \frac{.2765412 - .01722}{.0079346} = \frac{.2593212}{.0079346}$$

$\therefore r = 33$ ohms

$$x = .01148 \times 33 + 1.5 \times .01148 = \frac{.01148 \times 33 \times 3}{2} = .56826$$ ohm

Bay
Bridge
Bridge
Bridge

[THIS BOOK WAS USED IN BOTH DIRECTIONS. THE FOLLOWING PAGES WERE FILMED FROM THE BACK END FORWARD.]

Base	Acidizer	P Electrode	N Electrode	at low heat coarse	at low heat fine	at red heat coarse	at red heat fine	after N.C. low coarse	after N.C. low fine	after N.C. red coarse	after N.C. red fine
Phosphoric Acid	Hydrometric H	Carbon	Platinum			20	5			10	28
"	"	Iron	Carbon			60	53			50	48
"	"	Copper	Carbon			25	30			33	29
"	"	Nickle	Carbon			10	18			15	28
"	"	Silver	Carbon			14	21			8	17
~~Sulphur Acid~~	~~Electric Acid~~	~~Iron~~	~~Carbon~~								
Phosphoric Acid	Chlorohydric	Iron	Carbon	Thick as Maple syrup							
"	"	Copper	Carbon	10	28	5	25	8	24	13	40
"	"	Nickle	Carbon	30	55	31	33	21	44	34	35
"	"	Silver	Carbon	9	35	25	28	5	24	10	25
"	"	Carbon	Platinum	15	39	10	25	11	20	10	20
				5	11	11	25	5	15	3	9
Thick as Treacle as Maple syrup											
Phosphoric Acid	Chromic Acid	Nickle	Carbon	10	18	22	34	4	10	25	36
"	" "	Copper	Carbon	11	35	36	32	6	20	34	28
"	" "	Iron	Carbon	81	48	57	55	10	36	50	46
"	" "	Silver	Carbon	5	13	8	23	3	16	10	23
"	" "	Carbon	Platinum	1	10	10	28	2	12	9	25

Great chemical action on adding Chromic Acid to Base

Gain	Cricibles	Pulverizer	Mt. Oxide	a	Low Heat b	a	Red Heat b	a	Short cherry b	a	Short Cherry b
Plumbago	Parkinson & Se	Iron	Carbon	5	30	48	50	33	55	48	45
"	" "	Copper	Carbon	25	44	43	45	15	29	36	39
"	" "	Nickle	Carbon	3	1	25	38	1	3	20	38
"	" "	Silver	Carbon	8	26	35	43	5	15	25	40
"	" "	Carbon	Platinum	0	0	13	13	0	0	13	15
No Chemical action when Peroxide added to Sulphur											
Iron	Parkinson Sim	Iron	Carbon	35	53	40	38	26	48	27	37
	" " "	Copper	Carbon	13	34	20	33	9	8	14	30
	" " "	Silver	Carbon	6	5	12	29	4	5	10	23
Pulverized Coal		Nickle	Carbon	3	11	9	22	1	9	10	23
		Platinum	Carbon?	1	2			0	3		
Platinum cleaned with Fire			Platinum			5	20			3	18
Sens. of Iron Oxide. 4 as from Iron Oxide											

Zone Prospecting Area	Geologist Carbonic Acid	Iron	Carbon			1	5	3	7			Signature Thos Robinson Sigmund Pickle J. Mauss
"	"	Copper	Carbon			13	43	10	49			
"	"	Nickel	Carbon			10	26	6	10			
"	"	Silver	Carbon			5	23	3	18			
"	"	Platinum	Carbon			3	1	1	0			
Zone Prospecting Acid	Geologist Carbonic Acid	Iron	Carbon			4	24	7	25			Sigmund Pickle Thos Robinson J. Mauss
"	"	Copper	Carbon			25	50	22	47			
"	"	Nickel	Carbon			7	18	1	15			
"	"	Silver	Carbon			5	25	4	21			
"	"	Carbon	Platinum			3	30	5	29			
Zone Prospecting Acid	Geologist Carbonic Acid	Iron	Carbon			3	11	26	36			Signature J. Mauss
"	"	Copper	Carbon			55	51	55	57			
"	"	Nickel	Carbon			7	9	5	10			
"	"	Silver	Carbon			11	26	10	25			
"	"	Carbon	Platinum			4	9	3	7			

| | | |

76 4-016
83. 8. 16 4.

16064
03183
12878

16064
9
144576

4.016
4
16064
8032
24096

8164
39
73476
24492
03183396
78
3547165
2238672
2483458
4.096
22425278
12878
954732
901146
34.

12878

10½

	Long		Short		Long		Short			
	a	b	a	b	a	b	a	b	+ Vac.	— Vac
Dr. Johnson	30	36	30	33	36	25	25	25	Dron	C
	30	35	29	36	16	12	12	8	Cu	C
	14	29	9	21	3	3	1	1	Ni	C Ni
	25	33	16	13	26	16	18	11	Ag	C
	0	7	1	8	5	13	9	17	C	Pt
Dr. Johnson	21	42	30	42	45	50	41	45	Sn	C
	15	36	30	28	40	17	41	36	Cu	
	5	7	8	20	31	25	25	20	Ni	C
	15	23	11	29	23	49	55	41	Ag	
	4	9	3	5	9	5	8	4		Pt
Dr. Johnson	5	3	9	5	10	14	11	12	Sn	C
	21	23	21	18	11	18	8	17	Cu	
	3	15	3	17	0	0	0	0	Ni	
	17	24	8	22	27	18	21	13	Ag	
	0	1	0	3	13	15	11	24	Pt	Pt
Dr. Johnson	12	38	29	30	17	20	18	13	Sn	
	28	23	28	29	16	14	14	10	Cu	
	13	24	20	29	11	9	8	1	Ni	
	3	4	3	4	24	35	21	29	C	Pt
	24	25	18	20	33	34	28	23	Ag	

	Long		Short		Long		Short			
	a	b	a	b	a	b	a	b	+ Vac.	— Vac
Dr. Johnson	3	19	3	21	19	13	15	9	Dron	C
	4	23	4	16	29	13	10	3	Cu	C
	0	12	1	5	8	14	5	3	Ni	C Ni
	4	20	4	19	3	5	3	9	Ag	C Ag
	3	9	4	15	13	20	15	23	Pt	Pt
Dr. Johnson	35	27	31	25	23	15	20	13	Sn	Sn
	15	13	11	10	15	17	16	9	Cu	C
	23	15	14	13	33	16	18	13		Ni
	11	8	13	10	3	3	4	3	Ag	
	4	9	1	4	35	20	30	21		Pt
	Dron	Dron	allow	and	red	list	with	accent	is	joined
Dr. Johnson	19	40	30	45	15	15	10	9	Sn	C
	28	46	36	46	15	16	5	6	Cu	C
	29	30	33	30	0	0	0	0	Ni	C
	25	45	11	24	21	21	15	15	Ag	C
	8	10	0	4	8	10	8	18	Pt	Pt
									Dronage	not used
Dr. Johnson	8	10	8	17	0	1	0	1	Sn	C
	3	16	15	26	3	5	0	6	Cu	C
	3	9	3	8	1	1	1	3	Ni	C
	4	24	5	23	3	15	0	0	Ag	C
	0	0	0	0	13	15	16	15	Pt	C
					13	13	16	15	C	Pt
	Over									
	Go down and patch short									

a	B	C	C a.T B					Iron	Carbon
27	42	39	43						

Tbd.

Barium Oxid																			

3 ohms

45

73 61

3.274 1.964

.037 .0037

121.
007.
114.

22938 13748
9822

.121 | 505892

.007 | 2668

.12 4.5

121
455
605 187

605
121 114 | 359
242
.187 | 17

605

3.484

.54

Base Boric Acid
Oxidizer Sulphuric off K
very rid { a 14 14.25.25.33
{ 80 0 43.45.55

Carbon + Electrode
Platinum Electrode
~~Absolute~~ hot { 933.25 19.
rid { 345.55 45

Acids { a 20 25 9 11
{ 45 46 33 31

[ITEM FOUND IN BOOK]

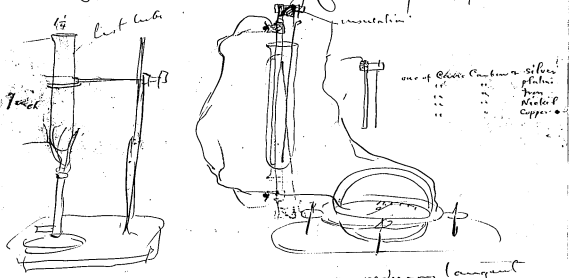
Cable Address "Edison, New York."

From the Laboratory of Thomas A. Edison.

Subject, _____ Orange, N.J., Feby 17 1888

John

Have Gladstone buy following —



[ITEM FOUND IN BOOK]

27 February — Lemon color

1st Suggestion: Oxygen gas & Electricity

2nd Sulphur will bleach by passing the fumes under it in a close room with the tobacco in soft order but by combining with the water it makes it taste bitter & smells sulphurous —

By first immersing the leaf in Ammonia water which makes it blackend then giving it a bath by peroxide. My dear sir it will turn a beautiful color but then so much in delight not to be unpleasant & [illegible] is not improved —

Too much heat reddens leaf first round the edge this is spots visible on both sides — called spotting

Too little heat stains facesides of leaf dull brown called sponging

Sulphate of Soda 1 part —
Peroxide Barium 2 part —
dissolve in 50 parts water is a good bleacher but too responsive & takes too much out of it —

By dosing with as much liquor as it will carry without dripping & burning sulphur under it in house in a tight room it will bleach but trouble is to get the smell out — also to smoke it & destroy the sulphur fumes will do it but has to be kept too long

Particulars of samples.

not needs no treatment worth $65 100th

No 2 very fine quality leaf bad color coming in & going out of case. worth $35
If improved worth $125.

No 3 blotched muddy leaf of silky texture $15
If bright worth $65

Hop aircured. worth $11 if bright $100.

No 5 aircured. $9 — $75

$84 is sample to copy from —

Take a few leaves at a time & match them keeping ple aside to compare with after process —
Moisten leaf by wrapping it up in damp cloth in a warm room — This is for leaf tobacco —
Treat the aircured red tobacco in any solution that will not change smoking or chewing qualities or take too much from out of it —

March 19

Suggestion. Take the green leaf & dissolve green stop in it and expose to strong electric light in moist atmosphere saturated with oxygen gas & then raising the heat in dry room for the color. Chlorine gas is a bleacher & might act in place of Sulphur —

[ITEM FOUND IN BOOK]

Buffalo
9th March 1888

J. W. Gladstone

Table of best results of Pyro Battery Experiments

Combinations	Temperature	Pole Pick	Pole Stick	Galvanometer Coarse	Galvanometer Fine	Ohms Volts Pole Rs	Volts E.M.F.	Guncotton
Bisulphate Potash 50% Borax 50%	Red Heat	Carbon	Iron	20	10	2½	.053	Glycerine
Sulphate Soda 50% Borax 50%	Red Heat	Carbon	Copper	50	30	2½	.167	Castor Oil
Sulphate Soda 50% Borax 50%	Red Heat	Carbon	Copper	50	38	4	.176	Castor Oil
Boracic Acid 1/3 Sulphate Lime 1/3 Caustic Soda 1/3	Red Heat	Carbon	Copper	50	25	1½	.1323	Sweet Oil
Bisulphate Soda 50% Borax 50%	Bright Red Kryolo.	Carbon "	Silver "	37 415	33 41	6 6	.1813 .2405	Glycerine
Boracic Manganese 50% Borax 50%	Bright Red	Carbon	Silver	69	55	3	.4434	Castor Oil
Caustic Soda 25% Boracic Lead 75%	Bright Red	Carbon	Silver	70	56	3	.4578	Castor Oil
Chlorate Potash 70% Caustic Soda 30%	Low Heat	Carbon	Silver	33	63	10½	.6342	Water
Borax 50% Bisulphate Potash 50%	White Heat	Carbon	Platt	60	46	3½	.3206	Glycerine
Borax 50% Boracic Manganese 50%	White Heat	Carbon	Platt	69	63	5	.627	Castor Oil
Borax 50% Boracic Manganese 50%	Bright Red Bright Red	Carbon	Platt	60 65	55 61	9 5½	.4179 .5558	Castor Oil Castor Oil

[ITEM FOUND IN BOOK]

Combinations	Temperature	Plate	N Black	Galvanometer Boracic Acid	Ohms Inf Res	Volts Elec	Consistency
Sulphate Manganese 60% Borax 40%	Red Heat	Carbon	Plat.	61	55	5	·4134	Castor oil Cr Add on finishing heating –
Nitrate Potash 50% Borax 50%	White Heat	Carbon	Plat	66	42	2	·2911	Olive Oil
Sulphate Soda 50% Borax 50%	Red Heat	Carbon	Plat	66	43	2	·2911	Olive Oil
Nitrate Potash 60% Caustic Soda 40%	Low Heat	Carbon	Plat	80	66	1½	·6306	Olive Oil
Chlorate Potash 50% Caustic Soda 50%	Low Heat	Carbon	Plat	75	58	2	·4838	Water
	Dull Red	"	"	64	66	8	·7307	"
Chlorate Potash 75% Caustic Soda 25%	Red Heat	Carbon	Plat	61	48	3½	·3339	Olive oil
Chlorate Potash 35% Peroxide Manganese 35% Caustic Soda 20% Glac Phosphoric Acid 10%	Low Heat	Carbon	Plat	76	56	1½	·4457	Thick Pasty mass
Chlorate Potash 70% Caustic Soda 30%	Low Heat	Carbon	Plat	68	62	5	·5757	Water –
Peroxide Lead 75% Caustic Soda 25%	Bright Red	Carbon	Plat	78	58	1	·4706	Castor Oil
Boracic Acid 50% Molybdenate Soda 25% Glacial Phosphoric 25%	White	Carbon	Plat	47	58	11	·3365	Glycerine
Nitrium Molybdenic 25% Sulphate Strontia 75%	Very Red	Carbon	Plat	70	63	4	·605	Castor Oil

[ITEM FOUND IN BOOK]

Combinations	Temperature	Pt Crucible	N Crucible	Calcium magnesia Crystal.	Zinc	Ohms Sulphr	Volt E.M.F.	Consistency
Sulphate Soda 75% Boracic Acid 5% Sand 20%	White Heat	Carbon	Plat	65	65	7	.729	Molten Iron
Sulphate Soda 70% Boracic Acid 5% Sand 20%	White Heat	Carbon	Plat	70	59	3½	.5219	Molten Iron
Cresolic Soda 25% Sulphate Copper 25% Red Lead 25% Sand 25%	Red Heat	Carbon	Plat	60	50	4	.3812	Molten Iron.
Sulphate Soda 90% Boracic Acid 10%	White Heat	Carbon	Plat	45	65	19	.52	Castor Oil.
Sulphate Soda 75% Glacial Phosph. Acid 25%	Bright Red	Carbon	Plat	55	46	4½	.2958	Glycerine
	White Heat	"	"	54	40	3	.2478	"
Sulphate Soda 75% Boracic Acid 25%	White Heat	Carbon	Plat	74	69	4½	.5122	Molten Iron.
Natrium Metaphosphate 75% Boracic Acid 25%	Dull Red	Carbon	Plat	50	46	5	.2816	Semi liquid
	Bright Red	"	"	53	50	5½	.3439	" "
	White.	"	"	54	48	4½	.3308	Castor Oil.
Sulphate Manganese 75% Natrium Metaphosphate 25%	Bright Red	Carbon	Plat	48	35	2	.1534	Castor Oil.

The Combinations with Chlorate of Potash and Nitrate of Potash are not satisfactory as there is great Chemical action and the Reaction part boils over the side of the crucible — The Bioxide of lead combination has a tendency at a high heat to form metallic lead which unites with the Platinum —

J. M. Paddock —

[ITEM FOUN IN BOOK]

Cable Address "Edison, New York."

From the Laboratory
of
Thomas A. Edison.

Subject, _____ Orange, N.J., _____ 188

Jan. Gabor 12. 3. 88

A unit defln 0.034 amp.

B - - 0.0032 "

[ITEM FOUND IN BOOK]

Cable Address "Edison, New York."

From the Laboratory
of
Thomas A. Edison.

Orange, N.J. 24 March 188

Gentlemen =

Using Carbonate of Soda as a base try with all the Electrolytes Various percentages of the following —

Protoxides of Lead – tin – Copper, Iron Zinc, Barium Strontium, Cadmium Antimony – Bismuth Cerium, Chromium, Tungsten Titanium, Nickel, Cobalt, Molybdenum Manganese, Magnesium, Aluminum

Peroxides, or sesquioxides Lead, Tin, Zinc, Manganese, Iron – Copper

proto Chlorides – Zinc, Tin – Copper – Strontia, Cadmium, Antimony – Bismuth Cerium Chromium Tungsten, Nickel Copper Cobalt Molybdenum, Manganese, Magnesium Aluminum —

Chromates of Lead Tin Zinc, Copper, Iron Manganese, Nickel —

[ITEM FOUND IN BOOK]

Cable Address "Edison, New York."

From the Laboratory
of
Thomas A. Edison.

Subject. _____ Orange, N.J. _____ 188

Then take ~~Chlorat~~ the following ex. 6 acids
Chloride Zinc - Sodium Dihydrogen phosphate,
Di ~~Sodium~~ Hydrogen Arsenate, Boric acid
Hydrogen ~~Potas~~ Potassium Arsenhydrosulphate, Hydrogen Borate.
~~Hydrogen~~ Potassic Sulphate, Ammonium Hypophosphate
~~Nitrate~~ Ammonia — Water Glass — ~~Chloride~~
Soda -

The oxidizing things are as described on 1st page
Peroxide lead, peroxide or black oxide manganese
Chlorate Potash, Nitro, Chromic acid - Bichromate
Potash, Bichloride tin Peroxide of Iron - Permanganate
of Potash - Carbolic acid - Sulphuret of Potassium,
Red lead - Heat the test tube up
just as high as it will stand,
Stir the liquid with the Electrodes,
& take the deflection on both coils -
See they start from Zero - see if there is
much polarization by holding current closed
for little while - ~~Have him make notes~~ make notes
he can do it in my room Edison

[ITEM FOUND IN BOOK]

Sulphuret of iron
" Lead.
Tin
Zinc.

— Sulphur —

[ITEM FOUND IN BOOK]

From the Laboratory
of
Thomas A. Edison.

Orange, N.J. _____ 188

Zinc Boracic — melts at high heat.

Chloride Strontia fuse high heat

Natrium Wolframic melts very high heat,

Sulphate Potassia melts very high heat

Plumbic Hypophosphorous — at first decomposes afterwards melts to a glass

Chloride Lead — fuse high temperature —

Oxidizer — Cupric Nitrate —

Sulphate Soda

From the Laboratory
of
Thomas A. Edison.

Orange, N.J. _____ 188

Calcium Lacto phosphoric — melts high temperature —

Strontium Bromic; " "

Natrium Saccinic — high heat

Soda Fluoride " "

Oxidizer — Natrium Hypermanganate, High heat

Natrium Iodic

Soda Molybdenite, "

Natrium Bitartrate "

Natrium Arsenicic "

Stannum Sulphuric Oxydat — "

[ITEM FOUND IN BOOK]

From the Laboratory
of
Thomas A. Edison.

Orange, N.J. _____ 188

Arsenic sulphide melts
Easily glassy.

Sulphuret antimony melts
high temperature

Oxidizer — Picronitric of ammonia
Picrate of potassa

Phosphate of magnesia. fuses high
heat.
Sulphite. Magnesia fuses high
heat.

Oxidizer — Zinc Picronitric,

From the Laboratory
of
Thomas A. Edison.

Orange, N.J. _____ 188

Kalium Stibium

[ITEM FOUND IN BOOK]

April 7th

At Louisville they bleach wrappers – viz remove the color one degree brighter & so it permanently. Called the sparkling process by alcohol – but it is sticky. –

Naturally cured yellow as spl in tin foil loses 15% color in being manufactured

---

Try aqueous solution acetate Potash + Chlorine –

2nd Oxalic Acid also with its alkaline salts –

Chlorine cannot be used to bleach substances containing nitrogen than becoming yellow by its action – $2HCl$ =

Faraday

Charcoal if made positive pole in dilute solution K_2SO_4 is capable of combining with the O evolved there & consequently unites with it producing CO_2 & Carbonic Acid in abundance

---

Mark cotton plate with hypochlorite & just clean [illegible] 1/12 way to add it together) subject it to strong pressure in Press before well powdered PbO_2 at top & bottom of cake.

Mark Aluminic plate & by the Carrying Circle Mention Engraving

[ITEM FOUND IN BOOK]

Particulars of Bleaching Tobacco.

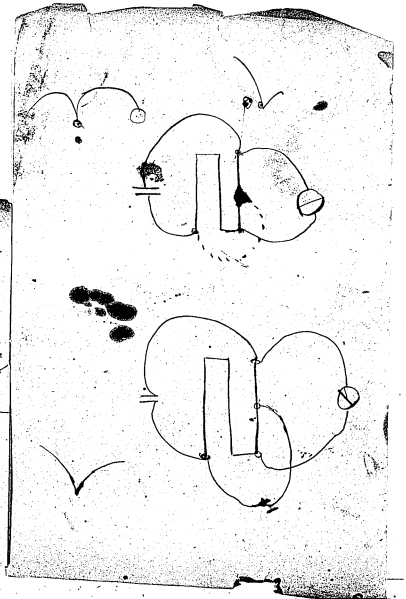
Materials used for 1 ℔ with cost.

7oz Chlorate Potash	18c ℔	8c
2 pg Cane Sugar	6c ℔	1½
10 pg Nitric Acid	6c ℔	4c
14 g Water		
		12½c

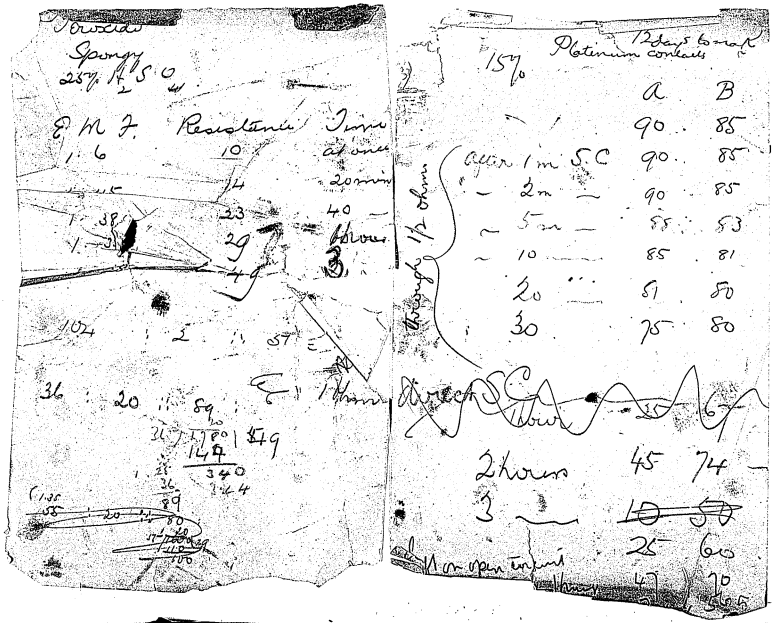
per lb

or say 25c per ℔ - - - - - - - - -

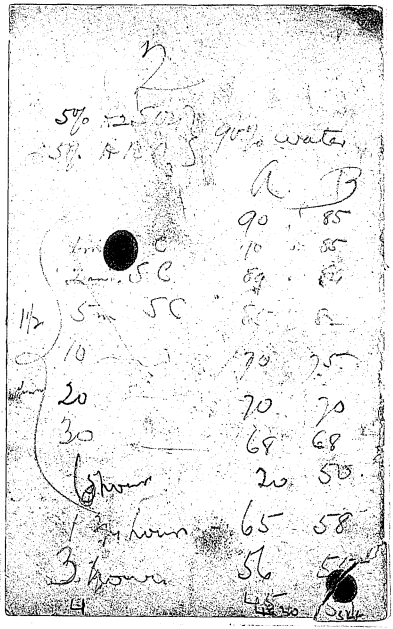
The leaf does not lose weight - - -



[ITEM FOUND IN BOOK]



[ITEM FOUND IN BOOK]



	A	B
	90	85
	70	55
	69	60
	60	8
10	70	75
20	70	70
30	69	68
1 hour	20	50
1½ hour	65	58
3 hours	56	5

Notebook, N-88-03-06

The dated entries in this notebook cover the periods March-May 1888 and December 1891-January 1892. At the front of the book are transcriptions of phonograph cylinder experiments conducted by Arthur C. Payne in 1888. From the back of the book forward are notes and calculations by Joseph W. Harris regarding various chemical analyses. Included are notes on ore assays; on a "new method of nickel determination"; and on the search for a substitute for borax, conducted for the Edison Phonograph Works. The front cover is labeled "520." The inside front cover is inscribed "Mr Payne Sepr 3 - 88 #520." The back cover is labeled "Qualitative Analysis Only. Harris." The pages are unnumbered, and several pages have been removed from the book. Approximately 160 pages have been used.

N-88-03-06

M Payne

Sept 3-88

#520

#1

Soluble in Lap Kali
Neutral reaction
Sodium 7 Cases.
Recognize Sodium acetate

#2

a chlorinated Substance.
Sol. in water. Barium Chloride Tes
neutral reaction " "
color, shaw yellow. Phosphorous

#3 a white Substance
Potassium 7 Cases,
Soluble in H_2O.
neutral reaction
Soluble in dilute H_2SO_4

#4 Reddish crystalline material
Easily melted in flame burns with a yellow flame, give off white vapors.
Melts on heated ~~[illegible]~~ H_2SO_4 leaves red Oil drops, melting in flame, to a light green colored ~~[illegible]~~ liquid.
Insoluble in cold H_2O, same effect on heated water, acid on H_2SO_4 slightly quick reaction.
(See Plan)

#5 Organic Compound.
~~Has a garlic Odor.~~
(see Next Page)

#5 (continued) ~~[illegible]~~ burns, give off inflammable vapors, brown
Slightly soluble in cold Alcohol
very Sol. in heated "
very Sol. in cold Ether,
Insoluble in cold H_2S water.
forms Oily drop in Hot H_2S water
In Sol. in cold Barium Chloride Sol.
forms Oil drop in pot.
~~Crystallizes out on high temp.~~

#5 Organic Compound.
Has a garlic odor,
Insol. Cold alcohol
" Hot "
" Cold Ether
" Hot Ether,

#4, melters at a high temp. and condenses at a dull red heat to a white solid, slightly ~~not~~ transparent, crystalline, hard ~~Ore~~

Fair - imitation of White Wax & Car.

#9. - brittle & very scratchy.

3/5/88.

Cerasine — = 100
Carnauba — = 80
Castor Oil = 10 drops = 480 mg.

Cerasine — = 100
Carnauba — = 80
Castor Oil = 40 drops = 1920 mg.

Cerasine — = 100
Carnauba — = 80
Castor Oil = 130 drops = 6240 mg.

#5 (continued)

Sol. Bain Chloride Cold

" " Hot

" cold H_2SO_4 neutral

" Hot " "

" Sulphate Soda 1145

" Hot " "

Ash Black.

#6 Red Powder

Iron flame, effervesces and jumps from holder!

Soluble in concentrated H_2SO_4

Boiled with caustic soda, boils and gives off vapors.

H_2SO_4 changes color to a dirty green

Chlorine precipitate floats

Dilute H_2SO_4 changes the color

6/7/[illegible]

Cerasine = 100
Carnauba = 50
Castor Oil = 10

Cerasine = 100
Carnauba = 75
Castor Oil = 50

Cerasine = 100
Carnauba = 100
Castor Oil = 50

Cerasine = 100
Carnauba = 200
Castor Oil = 50

#6 (continued)
On boiling Dried Orange yellow
dissolved in H_2O gave a
green & yellow solution.

#7 a light brown Powder
gives off dense white vapors when
heated, leaves a black ash.
melts and sublimes at a high
temperature.
slightly sol. in cold dilute H_2SO_4
more " boiling " "
slightly sol. in cold H_2O
more in boiling "
very slightly sol. in Ether, produces
a reddish purple color.
very slightly sol. in alcohol
Contains Chlorine
neutral reaction
slightly sol. in H_2SO_4 conc.
Slightly sol. in Barium Chloride Solution
Sol. in strong HNO_3 cold
" " " " Hot, produces

3/8/04

Yellow Ozokerite = 100
Carnauba = 30

Yel. Beeswax = 100
Carnauba = 40

Crude Japan Wax = 100
Cerasine = 100
Carnauba = 60

Yellow Ozokerite = 100
" Beeswax = 100
Carnauba = 70

Yellow Ozokerite = 100
White " " = 100
Carnauba = 80

H7 (continued)
chiefly crystally colored solution.

H7
Whole Powder,
Sodium flame,
soluble in reaction, neutral reaction
less sol. in Hot water
contains chlorine,
soluble in dilute HNO_3, Hot & cold
insol. in Ether
very slightly sol. in Hot & cold
alcohol
insol. in H2 Sucrose
very slightly sol. in Hot & cold
Benzin chloride.
Soluble in strong HNO_3, deoxidizes it,
the Nitric acid

Probably a silicate of Soda

8/9/88.

Paraffine = 100
Carnauba = 80
alpha Naphthol = 4

Yellow Glycerite = 100
Carnauba = 50
Castor Oil = 10

Yellow Glycerite = 100.
Carnauba = 70
Castor Oil = 50

Yel. Glyc. — = 100
Carnauba = 100
Castor Oil = 50

Yel. Glyc. — = 100
Carnauba = 200
Castor Oil = 50.

Hg

A very crystalline substance

Sol. in water,

probably neutral reaction, difficult to prove, on account of color

Slightly sol. in dilute H_2SO_4.

Potassium flame,

Sol. in Hot Nitric acid -

Potassium Permanganate

H10

A white crystalline substance

Sodium flame,

Alkaline reaction,

Soluble in water contains chlorine,

" in dilute H_2SO_4, more so when heated

3/10/88

Yellow Oxykerite = 100

Carnauba = 80.0

Castor Oil = 0.0

Yel. Ozk. = 100

Carnauba = 40.0

Castor Oil = 0.0

3/16/88

Ceresine — = 100

Carnauba - = 100.

Caustic Potash = 3

[Ceresine 100 + (Car. 50 + KOH. 40 + C_2H_5O. 50) 20] = 100

∴ Carnauba = 80

Ceresine (residue by ether extraction) = 100

Carnauba = 15

Good – hard – no scratch – little sticky
N.B – affinities found to be caused by the
Electrical properties.

Good – hardness – no scratch –
good talk – still sticky –
(Electrical.)

Cerasine = 100
Carnauba = 80
Metallic Sodium = 1½

"

3/28/88.

Syrian Asphalt = 100
Carnauba = 100
Crude Japan Wax = 60

"

Syr. Asphalt = 100
Carnauba = 100
Crude Jap. Wax = 25

"

Syr. Asphalt = 100
Carnauba = 125
Crude Jap. Wax = 60.

"

Syr. Asphalt = 100
Carnauba = 100
Hulu Beeswax = 90.

Not a good mixture.

Well strained - mixture better.

Good - cuts well but shade too soft - not very electrical - talks well but has slight scratch - somewhat rotten + brittle.

very Good - harder - but more electrical - good talk - still brittle.

Too soft + rotten.

4/4/PF

Carnauba = 100
Coal Tar = 40

"

Carnauba = 100
Coal Tar = 40

"

Carnauba = 100
Coal Tar = 20
Crude Jap. Wax = 20

"

Carnauba = 100
Coal Tar = 20
Crude Jap. Wax = 10

"

Carnauba = 100
Crude Japan = 25
Coal Tar = 20

Good - good bath - no scralit + good cut - but - electrical.

Shade bitter

4/5/88.

Carnauba = 100
Crude Japan = 10
Coal Tar (strained) = 20

Carnauba " = 100
Crude Japan = 5
Coal Tar (strained) = 20.

Carnauba " = 100
Crude Japan = 15
Coal Tar (St.) = 15

Sipian Asphalt = 100
Crude Japan = 80

Sip. asphalt " = 100
Crude Japan = 100
Carnauba = 100

#11
A white powder
Insol. in water
very slightly sol. in hot water
sol. in Ether
Slightly sol. in cold Alcohol
More so in hot "
difficultly fusible, leaves a yellow
greenish colored slag, resembling glass
eventually sublimes.
Charges with H_2S water to a black powder
insoluble in it.
very slightly sol. in Barium chloride
turns to a dirty white powder.

#12 A white powder,
does not burn in flame,
fuses at a very high temperature and
sublimes again on cooling, but not the
same material.
dissolves with difficulty in dilute HCl &
the precipitate is held in solution.
C. P. H_2SO_4 liberates small bubbles of gas

Carmanta	—	100
Cerasin	—	30
Syp. asphalt	—	20

Cerasin	—	100
Carmanta	—	60
Coal Tar (purified)	—	10

Cerasin	—	100
Carmanta	—	25
Syp. Asphalt	—	5

Paraffin	—	100
Carmanta	—	40
Alpha Naphthol	—	5

Paraffin	—	100
Carmanta	—	50
Alpha Naphthol	—	5

Paraffine — 100
Carnauba — 75
alpha Naphthol — 5

Gum Hamar — 100
White Wax — 100

Gum Hamar — 100
Paraffine — 100

4/14/88

Cylinder — 100
Carnauba Compound 50
Gutta percha — 23 No. 2.

Ceresine — 100
Carnauba — 145
Gutta percha — 25

---

very good - beautiful cut - continuous shaving - good lath - hard + non-electrical.

adopted as a reg. cylinder - No. 2. 4/15/88

185
1155
950
585
3650

23
75.75
585
585 ; 23 : 100 %
585) 2300.000 (3.9326
1755
5450
5265
185

#12 (continued)

Insoluble in HNO_3, gives off bubbles of a gas.

Insol. in H_2SO_4 acidified, gives off bubbles of a gas. changes to a black powder

(This gas is probably Air)

Fuses with difficulty at a high temp.

Fused mass unaffected by HNO_3

" gives off white fumes when heated.

" " H_2SO_4 cold

Unaffected by HCl cold

" " " hot, but shrinks the mass.

" " HNO_3 hot.

#13 a reddish brown powder.

does not fuse at a red heat, but seems to form a different compound.

changes at a very high temp. to an purple powder.

HNO_3 gives off a light vapor when in contact with the residue.

H_2SO_4 does not affect it cold, but when hot changes its color to a light purple, and gives off dense vapors. (the residue)

Strong sodium flame,

Unaffected by dilute H_2SO_4

heated, gives off vapors + water with it.

These vapors may be due to sulphur in H_2SO_4, as a sample of it gave the vapors. C.P. H_2SO_4 acts the same.

unaffected by cold HCl., heated gives off vapor, and changes the nature of the powder. Turns reddish purple in color.

Unaffected by H_2S under H.T or cold

" " Barium Chloride H.T or cold.

" " cold Ether, very slightly

Sol. in Hot Ether.

Sv. sol. in cold Alcohol,

" " " Hot

Sv. sol. in H_2O, Neutral reaction.

#14 White Powder,

Potassium flame

When heated, sputtered out in long tails,

like #6. Sublimes at a high temp.

sublimes even when heated slowly

#14 (Continued)

Nitric Acid does not affect it, but on heating fuses not spread, and turns to a black mass. fuses & ~~sublimes~~ sublimes on further heating.
unaffected by HCl acid, at a high temp. turns orange yellow. still higher temp, sublimes
soluble in H_2SO_4, on heating, boils & sublimes leaves a white amorphous mass behind, heating still further, sublimes.
Insol. in dilute H_2SO_4.
" " H_2O. Hot or cold.

H_2S water changes it to a darker color.
Unaffected by Barium chloride, Hot or cold.

Caustic soda changes it to a black compound.

Insol in Ether
" " Alcohol cold or hot.

changes to a yellow when burned on charcoal by a blowpipe.

#15 a white powder.
Potassium flame.
slightly sol. in water after some time, potas. again on heating.

3/3/98

Camauta –	100
Hamar Varnish –	20
Camauta –	100
Hamar Var. –	20
Camauta –	100
Hamar Varnish –	40
Camauta –	100
No 1 Polishing Varnish –	10
Camauta –	100
No 1 Pol. Var. –	20
Camauta –	100
No 1 Pol. Varnish –	40

H.5 (continued)

soluble in dilute H_2SO_4.

solubility increased on heating.

sol. in caustic soda, upon heating with caustic soda on pt. spoon, gives off a little gas and a metallic pt. spoon with all different shades. This coloring matter dissolves and dissolves in NaOH sol., but on heating again turns green.

Dissol. in sol. HCl produces a yellow green liquid on heating.

Slightly sol. in sol. HNO_3, heated gives off a gas, [illegible] a white mass, which is partially [illegible] same powder on heating on pt. spoon, powder sublimes and turns a yellow green color. (Pure powder)

$$\begin{array}{r} 6.5 \\ 3.8 \\ \times 6 \\ \hline 18 \\ 36 \\ \hline 21.8 \end{array}$$

$$\begin{array}{r} 30.3 \text{ mg} \\ \times 6.5 \\ \hline 151.5 \\ 181.8 \\ \hline 196.95 \\ \times 5.8 \\ \hline 1137.1 \end{array}$$

Camauta — 100
White Japan Varnish — 10

Camauta — 100
White Jap. Var. — 20

Camauta — 100
White Jap. Var. — 40

Camauta — 100
Brown Jap. Var — 10

Camauta — 100
Brown Jap. Var. — 20

Camauta — 100
Brown Jap. Var — 40.

Composition of materials put in small fuse plugs.

1 100 parts plaster Paris, 6 parts soda nitrate, mixed with H_2O

2 100 parts fire clay, 4 parts lead chromate

3 100 parts fire clay, 100 parts chlorinated oil

4. 100 parts fire clay 100 parts crude chlorinated napthalene

5 100 parts fire clay, 50 parts chlorinated napthalene

6 100 parts fire clay 25 parts chlorinated napthalene

7 100 parts fire clay, 25 parts chromium chloride

8. Insulation

9 Earlier Insulation

Carnauba — 100
Furniture Varnish — 10

Carnauba — 100
Fur. Var. — 20

Carnauba — 100
Fur. Var. — 40

Carnauba — 100
Black Asphalt Var. — 10

Carnauba — 100
Black Asp. Var. — 20

Carnauba — 100
Black Asp. Var — 40

Carnauba — 100
Elastic Oil Finish — 10

Carnauba — 100
Elas. Oil Fin. — 20

Carnauba — 100
Elas. Oil Fin. — 40

Carnauba — 100
Pale Coach Body Var. 10

Carnauba — 100
Pale C. Body Var. — 40

Weight of components of insulation

$PbCO_3$ 298 grams.

Weight of dish and insulation 726.

Weight of dish 293 grams

Weight of chlorinated oil 135 grams

% $PbCO_3$, 68.815

% Oil, 31.185

To generate chlorine, use

370 grams manganese and 900 grams HCl.

298	
+ 428	
726	
293	
433	
135	
433	
298	
135	
679.2	

Carnauba — 100
Superior No. 1 Coach Var. — 10

Carnauba — 100
Ship. No. 1 Coach Var — 40

Carnauba — 100
White Copal Varnish — 10

Carnauba — 100
White Copal Varnish — 40

Carnauba — 100
Spar Composition — 10

Carnauba — 100
Spar Composition — 40

With Carnauba as a base (100 parts)
used the following substances in the
proportions of 10 parts & 40 parts: —

Extra Brown Shellac Spirits: —
No 1 Polishing Varnish: —
No 1 Furniture Varnish: —
Diamond Coach Varnish: —
No 1 Coach Varnish — : —
White Shellac Spirits.
No 1 Preservative.
Extra Polishing Varnish.
Brown Shellac Spirits.
No 2 Preservative.
Hamar Varnish.
Black Leather Varnish.

Weights & measures, Mole & oil
11.2 grams.
200 grams Ammonia Hydrate.
1250 " Oleic.

5562
2.39
50.58
16686
11.24
1329.8

7.5) 40.602 (5362
37.5
3.02
1.50
1.52

With Cassauba as a base (100 parts) used the following substances in the proportions of 10 parts + 40 parts:—

Aniline Brown.
" " Black.
" " Gray.
" " Cochin.
" " Orange.
" " Fuchsin.
" " Blue.
" " Chloride.

With Cannabis as a base (100 parts) used the following substances in the proportions of 10 parts & 40 parts:—

Oil Spruce
" Cubebs
" Paraffin
" Turpentine
" Lard
" Mustard Seed.
" Linseed.
" Sperm
" Palm
Cocoa Butter,
Lanolin.
Lard.
Tallow
Venice Turpentine
Vaseline.

Also used Spirian Asphalt as base (100 parts).

With Cannula as base (100 parts) used the following substances in proportions of 10 parts to 40 parts:-

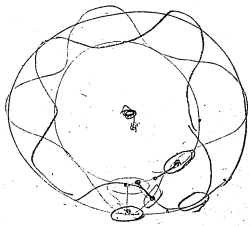
Gum Kino	Gum Myrrh.
" Bdellium.	" Thus.
" Myrrh.	" Olibanum
" Tinc	" Sanguis Draconis
" Ladanum	" Amalgam
" Sandarac	" Asafoetida
" Benzoin	" Benzoe
" Gamboge	" Scillae
" Almadina	" Shellack
" Ammoniac	Kauri.
" Hemar	Benzoe
" Mastic	Guiac.
" Arabic	Guttae.
" Amine	
" Elemi	
" Chile	
" Euphorbium	

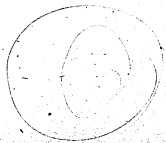
With Carmanta as base (100 parts) used following substances in the proportions of 10 parts to 40 parts:—

Benzoic Acid
Formic " "
Picric " "
Oleic " "
Tartaric " "
Gallic " "
Picric " "
Ammonia
Caustic Potash,
" Soda
Cyanide Potash.
Chloral Hydrate
Stannous Chloride
Syrian asphalt.
Iodine
Ammonium Sulphide
Sulphur.
Stearic Acid

Naphthalin,
alpha Naphthol,
Coal Tar Creosote
Carbolic Acid:
Camphor.

Also used Syrian asphalt as base (100 parts)





Carnauba — 100
Resorcin — 5
Caustic Potash — 2

"

Carnauba — 100
Resorcin — 20
Caustic Potash — 15

"

Carnauba — 100
Crude Japan Wax — 20

"

Carnauba — 100
Crude Japan Wax — 40

"

Syrian asphalt — 100
Crude Japan Wax — 5

Syrian asphalt — 100
Crude Japan Wax — 10

Syrian asphalt — 100
Crude Jap. Wax — 100

Syrian asphalt — 100
Crude Jap. Wax — 50

Syrian asphalt — 100
Crude Jap. Wax — 20
Naphthalin — 20

Syrian asphalt — 100
Ceresin — 20
Naphthalin — 10

Syrian asphalt — 100
Arsenic — 20
Naphthalin — 40

Syr. asphalt — 100
Arsenic — 20
Chloral Hydrate — 10

Syr. asphalt — 100
Arsenic — 20
Chloral Hydrate — 40

Yellow Ozokerit - gave some fair results with 20 parts Jel. Osk - too brittle - with 40 parts, still too brittle - gave a powdery cut + dull scrape - with 60 parts Jel. Osk. gave very good results; only slightly sticky. Int. Paint good shiny cut + scrape, + a point - scrape looking very smooth under the microscope.

Yellow Beeswax - acted similar to Jel. Osk, but on whole not quite as good.

Black Ozokerit - - Chemical -

Cocoa Butter, - cut in small proportion softens the gum, but leaves it dry sticky. appears to dissolve.

Oleate - only the Lead Oleate would mix well, made beautiful cut + scrape, but very sticky.

5/1/08

With Gum Elemi as base (60 parts) used following substances in the proportions of 20, 40 + 60 parts:-

White Ozokerit:-
Yellow " " "
Black " " "
Yellow Beeswax:-
Crude Paraffin -
Crude Japan Wax
Paraffin.
Cera Japonica
White Wax
Spermaceti.
Resinate
Stearin
Cocoa Butter.
Gutta percha
Gum Zinc
" Aluminum
Asphaltum
Crude Petroleum
Creosote
Carbolic Acid,
Coal Tar.

alpha naphthol:-
Oleate of Lead
" " " Strontium
" " " Aluminum
" " " Zinc
" " " Copper
" " " Lead + Copper
Palmitate of Aluminum.

Hamar — 100
Yellow Oxide — 60
Spumach — 15

"

Hamar — 100
Yellow Oxide — 60
Ora Japonica — 15

"

Hamar — 100
Yel. Oxe. — 60
Crude Paraffin — 15

"

Hamar — 100
Yel. Oxe — 60
Lead Chlate — 5

"

Hamar — 100
Yel. Oxe — 60
Lead Chlate — 25

"

Hamar — 100
Yel. Oxe — 60
Lead Chlate — 15

1/

Hamar = 100 } = 100
Jl. Oph. = 65

Lead Oleate = 10

---

2) Hamar — 100
Lead Oleate — 50
Camauba — 10

---

3) Hamar — 100 = Composition = gives fair
Lead Oleate — 50 scraps from a print - but quite sticky

Composition — 100
Jl. Oph — 50

---

4) Composition — 100
White Wax — 50

---

5) Composition — 100
Oriental Japan Wax = 30

Composition = 100
Jel. Glyk = 40
Gum Thus = 40

Composition = 100
Crude Japan = 0

Composition = 100
Camauba — 10

Composition — 100
Jel. Glyk — 10

Composition — 100
Camauba — 25

Composition — 100
Jel. Glyk — 25

Composition — 100
Jel. Glyk — 20
Almedina — 20

Composition — 100
Jel. Glyk. — 20
Gum Balata — 20

---

n.f.

Damar — 100
Lead Oleate — 50
Jel. Glyk — 20
Gum Almadina — 50

Damar — 100
Jel. Glyk — 65 = 100
Lead Oleate = 15

Gum Thus — 100
Oleate of Lead — 50

Soft.

Gum Thus — 100
Lead Oleate — 25

Perfect print scrape.

Lead Oleate — 100
Carnauba — 50 - 60 .. 70 + 80

Lead Oleate — 100
asphaltum — 40 .. 50 .. 60 .. + 70

---

asphalt — 100
Lead Oleate — 10 + 25

Electrical

Rosin — 100
Lead Oleate — 10 to 50

Compounds Containing Slack
insulation & Sundry Waxes & Resins
Dec. 22-1891

# 1	Canada	10
	Insulation	90
# 2	Canadian	10
	Ins	90
# 3	White Bees Wax	10
	Ins	90
# 4	Japan Wax	10
	Ins	90
# 5	Assyrian asphalt	50
	Ins	50

the asphalt should be melted first and
ins. added while hot.

Quantities	of	weights
100	grams	1#
50	"	3/4 "
20	"	9/16 "
10	"	1/2 " ounce
5	"	3/8 "
(2) 2	"	1/4 " ounce
1	"	1/8 " fluid

#6	Aluminum Stearate	5
	Ins.	95
#7	Rosin	20
	Ins	80
#8	Stearic Acid	10
	Ins	90
#9	Paraffin	10
	Ins	90
#10	Ceresin	5
	Ins	95
#11	Gutta Percha	10
	Ins	90

With exception of Hamar & Mastix Thus, Chich, Almadina, the gums did not mix well – the majority not at all –

Hamar & Mastix gave best results.

With following gums as bases (100 parts) used Jel. Opiate in proportion of 60 parts –

Ammo	Guiac.
Tacamahac	Hemlock.
Thus.	Kino
Hamar	Bdellium.
Ammoniac	Myrrh.
Scillae	Tragacanth.
Sticklac	Chich.
Elemi	Almadina.
Mastix	Benzoin.
Sandarac	Arabic.
Kauri	Euphorbium.
Gamboge	Spruce.
Guttae.	Amalgam.
Olibanum	Assafoetida.
Sanguis Draconis	Boniac.
Ladanum.	
Copal.	

Made experiments with Kaolin, Plumbago, French Chalk, Precipitated chalk, mixed in all proportions with all the waxes & asphalts. - Found it hard to work - hard to keep from settling & N.G. as a talking surface.

Substitutes for Yel. Oyk. - White Wax - Japan Wax - Yel. Beeswax
Black Oxylands &c. but results not as good as with Yel. Oyk.

Hamar	—	100
Yel. Oyk	—	50
Cocoa Butter	—	10
Give fair results but shaving a little sticky.		
Hamar	—	100
Yel. Oyk	—	50
Cocoa Butter	—	20
More ~~sticky~~ & too soft.		
Hamar	—	100
Yel. Oyk	—	50
Cocoa Butter	—	15
Give good result - hard - smooth cut - smooth scrape - does not contract, & not sticky.		
Hamar	—	100
Yel. Oyk	—	65
Cocoa Butter	—	10
Too dry - powdery cut.		
Hamar	—	100
Yel. Oyk	—	65
Cocoa Butter	—	5

Weight of 12 carbon filaments
90.8 mg.

Weight of 19 carbon filaments 147.65 mg.
" " 19 " " 146.8
" " 19 " " 143.85 mg.
" " 19 " " 141 "
" " 12 " " 88.8

Qualitative analysis of Unknown chemicals.

#1 Sodium flame.
Does not fuse.
Dark brown coloy after heating on platinum.
Is not sodium acetate.
Soluble in cold Hcl.
" " Hot "
" " cold HNO_3
" " Hot " "

Give off fumes like burnt hair when highly heated.
Residue unaffected by HNO_3 when cold.
" " " Hot " "
" " " Hcl cold
" changed to a colourless white mass when heated in hot Hcl.

July 14 - 1891.

H1 White crystals
soft
on heating in tube, gave off white fumes, having an odor of garlic, fumes ascended the air in the form in rings, ignited at the mouth of the tube condensed on the sides to a yellow ppt, while at the bottom became black (inside.
The fumes are heavier than air
material turned a light tawny color at the mouth of the tube, the ppt was a light red.

H 1.

White powder, heated in a small glass tube gives off dense vapors, which ignited with slight explosion at the mouth of the tube. Vapors are heavier than air, and condensed on the side of the tube, a yellowish ppt. The white powder expanded, and changed to a tawny color.

On heating red hot, changes immediately on cooling to a white powder, but after a minute, becomes a very light pink.

Unaffected by dilute H_2SO_4 on heating.

Heated on charcoal, vapors burn with a green flame, turns to very faint pink color

fuses with difficulty in the oxydizing flame of a blowpipe, to a hard white bead.

gives no color ~~to~~ when heated with cobalt nitrate; lead remains white.

Heated with sodium carbonate and a drop of water, in charcoal, gives garlic odor, leaves an incrustation on the charcoal of a pinkish color.

Fuses readily with sodium phosphate, after the fumes have been driven off.

forms a very faint pink colored bead.

on continued heating, forms an amethyst colored bead with a white streak in it (on cooling) on long continued heating, comes down to a clear amethyst blue bead.

Slightly soluble in cold water, more soluble in boiling water.

Completely soluble on continued boiling

Acid reaction.

no precipitate formed with HCl. even on boiling.

no precipitate formed with H_2S water after boiling ~~to~~ expel the H_2S a few drops HNO_3 were added and boiled, turned to a clear straw yellow color.

Immediately on addition of Ammonia a precipitate forms which filtrates and often dissolves in the solution

addition of $(NH_4)_2S$ produces a yellow ppt.

The ppt washed and put in a beaker with water + some H_2S, sp g 1.12 enough to dissolve the ppt.

no nickle, no cobalt.

dilute H_2SO_4 produces no ppt.

Some alcohol produced a slight cloudyness, but partially redissolved on addition of more alcohol.

dilute H_2SO_4 added to the alcohol produced a decided cloudyness.

no calcium

dried small quantity with HNO_3, added drop of $K_4Fe(CN)_6$, shamrock color.

Examination of #1, according to Page 338.

ppt is found by $(NH_4)_2S$, more by H_2S

Barium chloride produces a ppt which is not ~~readily~~ dissolved by Hcl.

the filtrate from the $(NH_4)_2S$ after boiling to expel the H_2S is ppt by Hcl.

the ppt. is washed into a beaker treated with $(NH_4)_2S$ heated by steam filtered,

Hcl added to filtrate, produces a white cloudy ppt.

Absence of metals of group 6

To the ppt from $(NH_4)_2S$ after heating with aqua regia, is heated in an evaporating dish with some HNO_3 (dilute 20%), a white ppt is formed.

no mercury.

no lead.

no bismuth

no cadmium

no Barium

no Strontium

H 9.

a red crystal, seems to be a chromium salt

Soluble in water.

acid reaction.

Heated in a glass tube melts in its water of crystallization, further heating gives a dark green deposit on the side of the tube which is not a sublimate.

When the dark is heated, fumes are given off which give an alkaline reaction.

Heated on charcoal, decrepitates. leaves a dark green powder, even with Na_2CO_3 fuses with difficulty to with sodium carbonate

bright green opaque residue

H_2S produces a ppt of the solution in water

H 10

a white alum crystal.

Heated in a small glass tube, dissolves in its water of crystallization, gives off vapors of ammonia.

very alkaline reaction.

On heating on charcoal with $NaPO_3$ gives a clear bead on cooling. While heating dissolves very readily in the water of crystallization very easily fusible

Readily soluble in H_2O

alkaline reaction.

HCl produces no ppt. gives off fumes of sm NH_4Cl.

absence of silver & (mercurous) mercury.

acid reaction.

H_2S produces no ppt.

solution is colorless.

no chromium

color not changed by HNO_3.

No ppt. when neutralized with ammonia

no ppt on adding $(NH_4)_2S$.
no ppt on adding ammonium carbonate,
ammonium .

[THIS BOOK WAS USED IN BOTH DIRECTIONS. THE FOLLOWING PAGES WERE FILMED FROM THE BACK END FORWARD.]

(See Page 482, Treseniu's Qualitative Analysis).

Analysis of Solution containing one metal only. Metal required.

#1 clear solution, neutral reaction

H_2O, no ppt. sol. light yellow, strongly acid.

H_2S a slight ppt which redissolves on further addition of H_2S. nearly colorless.

NH_4Cl (after boiling off H_2S) turns [illegible] a reddish brown color, and produces a ppt.

NH_4OH produces a heavy ppt, and makes the color deeper.

$(NH_4)_2S$ dissolves the ppt formed by NH_4OH, and turns the solution a deep yellow color.

on boiling; the color deepens
then suddenly turns a deep yellow
again, with the formation of a ppt.
The ppt has a straw yellow color.
It is insoluble in HCl.

Boiled off H_2S completely, added
H_2O, straw colored solution.
added HNO_3, color, orange yellow.
added NH_4OH, no ppt.
added $(NH_4)_2S$, ppt after standing
way some time.
filtered, ppt dissolved in very dilute
HCl.
had a dark color

according to page 491

HCl no ppt
H_2S no ppt
NH_4Cl, NH_4OH, $(NH_4)_2S$, no ppt
$(NH_4)_2CO_3$ no ppt.

Na_2HPO_4, no ppt.

By reaction with H_2PtCl_6,
proves the potassium.
also by flame test.

(The platinic chloride solution acts very strongly with the heated residue, metallic platinum seemed to be precipitated.)

2

clear fluid. neutral reaction.

added HCl to strongly acid reaction. clear fluid.

H_2S produces no ppt.

NH_4Cl, NH_4OH $(NH_4)_2S$ produce no ppt.

$(NH_4)_2CO_3$ produces no ppt.

Na_2HPO_4 produces no ppt.

H_2PtCl_6 produces a slight ppt. evaporated to dryness and water added gives large ppt (yellow). Hence K.

3

clear fluid, neutral reaction.

added HCl, intense white curdy ppt.

Either silver, mercury, or lead.

is not lead.

is silver.

#4 clear fluid, neutral reaction

added HCl, no ppt.

H_2S no ppt, after heating

$(NH_4)_2S + NH_4Cl$, NH_4OH, no ppt.

$(NH_4)_2CO_3$ white curdy ppt

after standing over night, a precipitate formed in the HCl solution.

is therefore, either lead, mercurous or silver chloride.

a similar ppt also formed in the tube containing free HCl and H_2S.

(to be determined later)

#5

a clear fluid, very slightly acid reaction.

HCl produces no ppt, even on heating

H_2S produces no ppt

$(NH_4)_2S$ produces a ppt which dissolves on further addition of reagent.

HCl added, precipitated sulphur, and also gray ppt.

collected ppt on filter,
(to be determined later)

#6

a clear fluid, alkaline reaction (very probably solution of an alkali earth metal, or alkali metal)

HCl produces a slight ppt, which dissolved on further addition of HCl. also gave gas like a carbonate added reagent to strongly acid reaction

after evaporating (HCl, to dryness, i.e.) ppt (white, amyloidal) is soluble in water added small amount of HCl.
(before adding HCl, reaction acid).

H_2S produces no ppt.

NH_4Cl, NH_4OH $(NH_4)_2S$ produces a slight gelatinous ppt, which might be sulphur (i.e. sulphur).

$(NH_4)_2CO_3$ produces a ppt
(to be determined later)

7.

a cloudy fluid, very slightly alkaline.

addition of HCl precipitates a heavy ppt.

filtered, to filtrate added, dilute H_2SO_4, slight ppt, appears to be lead.

8.

a clear fluid, acid reaction

addition of HCl produces a heavy ppt, therefore either lead, mercurous mercury, or silver

is not lead.

is mercury. (mercurous)

9:

a clear fluid, neutral reaction.

added HCl, no ppt.

" H_2S, " ppt.

" NH_4Cl, NH_4OH, NH_4OH produced a slight turbidity which did not disappear on gently heating.

$(NH_4)_2S$ produced no ppt.

$(NH_4)_2CO_3$ produced a heavy ppt.

is, therefore, Ba, Sr, or Ca.

is Barium.

10

a turbid fluid, acid reaction.

HCl produces no ppt.

H_2S produces no ppt.

NH_4Cl, added, NH_4OH produces a white ppt.

$(NH_4)_2S$ dissolves the ppt produced by ammonia.

(to be determined later)

analysis of a thick fluid.
acid reaction, clear solution.

HCl produces no ppt.
not silver
lead
mercurous Hg.

H_2S produces no ppt.
no lead
mercuric Hg
Copper
Bismuth
Cadmium
Arsenic
Antimony
tin
gold
platinum
tetrad iron.

$(NH_4)_2S$ produces a heavy white ppt.
with evolution of H_2S gas.
ppt seems to be soluble in solution
to some extent

presence of
Iron
Manganese
nickel
Chromium
Cobalt
Zinc
aluminum.

White soln.
absence of iron,
cobalt
nickel

Qualitative analysis for nickle of sample #21 of Mr. Burns ores.

very small % nickle. little more than a trace.

4 clear fluid.
neutral reaction

HCl, no ppt, no silver, mercurous mercury, no lead chloride.

H_2S no ppt,
no lead sulphide, mercuric mercury, Bismuth, copper, cadmium, tin antimony arsenic, pt, golde

---

Preliminary Examination

is a white powder.
is unaltered at low temp.
" " " high temp
White incrustation on Charcoal
Cline green bead with sodium
meta phosphate, while hot,
colorless on cooling
When fused in large excess with $NaPO_3$, gives an enamel white bead on cooling in the flame,

either magnesium, calcium, lead.
cadmium, or zinc,

#5

a clear fluid, very slightly acid
reaction, evaporated, leaves a white
residue which decrepitates violently —
fused at a red heat,
gives no sublimate in a glass tube
on heating —
While evaporating, emits an odor,
somewhat resembling ammonia.
fused with water phosphate, gives
a clear bead on cooling
On fusing in charcoal flame, solidifies
to an opaque white bead.
Does not color flame when heated
with cobalt nitrate
is not luminous in blowpipe
flame,
is either Barium or aluminum in
appearance to be aluminum.
is Barium.

1 Dec. 10th 1891

a clear colorless fluid.
acid reaction.
HCl no ppt.
H_2S " ppt.
$(NH_4)_2S$ " ppt.
$(NH_4)_2CO_3$ white curdy ppt.

analyze the following substances

✓1 Silver — ores
✓2 Mercury (ous) — rocks
✓3 Lead — earths
4 Mercury (ic)
✓5 Bismuth — Ca, Ba, & Mg. earths
✓6 Copper
✓7 Cadmium
8 tin
✓9 Antimony
10 Arsenic
11 Gold
12 Platinum
13 Nickle
14 Cobalt
15 Iron
16 Manganese
17 Zinc
18 Chromium
19 Aluminum
20 Barium
21 Strontium
22 Calcium
23 Magnesium
24 Potassium
25 Sodium

Analysis of a mineral received Jan 7th 1892 from M. L. Ely, Adair, Iowa, supposed to be platinum ore, for all constituents.

metallic lustre
Gravity
scratches glass,
no streak.
Unaltered in O.F. & R.F. but forms a white incrustation, which may be osk.

With Borax bead, dissolves freely thus bead, in O.F. is a light red while hot, gradually turns darker and, when cold, is a bottle green color (emerald green)
Is unaltered in R.F.
With microcosmic salt, same as with Borax.
With Cobalt nitrate on charcoal in O.F. gives a greenish yellow incrustation,

No. R. 7, gives a very dark, nearly black, incrustation.

Analysis by the wet method.

Partially soluble in HCl, to a yellow green fluid.

H_2S on ppt. solution was a pale yellow precipitate.

4 drops nitric acid oxidized color changed to darker yellowish green.

a light flocculent ppt. formed on addition of ammonia, has a bronzish yellow tint (ferric hydroxide)

ammonium sulphide produces a black ppt.

ppt completely dissolved in dilute HCl.

dilute H_2SO_4 gives no ppt., no lime, strontia, calcia.

Heated some solution with HNO_3 added to a part $K_4Fe(CN)_6$, gave a ppt, which proves the presence of iron.

added $FeCl_2$ to part of HNO_3 solution added Na_2CO_3

no manganese, no zinc, trace aluminum.

Analysis of part insoluble in HCl, treated with nitro hydrochloric acid. H_2S produces a turbidity, which may be sulphur.

Qualitative analysis of a mineral
sent down by Mr. Edison on
Jan 26th 1892.

Color, Black generally, ranging
streak. Black
Luster. metalic
Structure, seems to be lamminated.
Gravity

Dissolves easily in fused borax
on platinum leaf.
While hot, appears red
" cold. " green by transmitted
light
When largely diluted with borax, light
green, very transparent,
contains iron, in large quantity.

not easily soluble in microcosmic
salt.
When hot, appears red, on cooling,
turns a little green, then gradually
turns clear when cold is perfectly
clear. (with small amount of assay).
With large amount of assay, it is
insoluble in bead. ~~of~~ On cooling first
turns a deep green then gradually clear
with the undissolved sample contained
within.
In reducing flame, on cooling turns
a deep red, from color, still insoluble.
When assay is dilute, after heating,
becomes green, gradually becomes nearly
colorless. When cold, a trace of green
color left.
Probably contains, nickel, manganese,
Iron, nickel, cobalt, tantalium, columbium
titanium tungsten, zinc, cadmium, lead, bismuth
antimony.

Not altogether soluble in HCl.
H_2S produces no ppt, even on boiling
color, after boiling off H_2S, is
slightly yellowish.
after addition of nitric acid
color is a yellowish green.
ammonia added gives a ppt. of iron
$(NH_4)_2S$ produces a black ppt, which
contains iron among other possible substances.
ppt collected on filter and treated with
cold dilute HCl dissolves completely with
evolution of H_2S.

no silver, mercury, lead
" bismuth cadmium, copper, gold,
platinum, antimony, tin, tetrad iron
and chromates.
no nickel + cobalt.
no Barium, no Strontium, no calcium.
no manganese, no zinc.

digested some one in Hydrofluric acid & HNO_3,

H_2S produces no ppt,

absence of lead, bismuth, cadmium, copper, mercury, gold, platinum, antimony, tin, & arsenic.

addition of HNO_3 turns it a brown color, by transmitted light, on boiling it turns a greenish yellow color, addition of ammonia produces a heavy ppt.

$(NH_4)_2S$ produces a heavy ppt, filtered and filter dissolved in dilute HCl, sulphur separates, but no residue.

no nickel, no cobalt.

no barium, no calcium, no magnesium

no sodium, potassium, lithium

contains titanium, iron,

Analysis of Swill-ore, for all constituents,

about 1 gram was ~~fused~~ dissolved in hydrofluoric acid, and changed to chlorides by HCl, which ppt. the silica, contains considerable.

H_2S gas passed through a portion of the solution,

Produces a white precipitate, which consists of separated sulphur. (Iron is present as a ferric salt.)

HNO_3 & NH_4OH added, produce a ppt of ferric oxide.

$(NH_4)_2S$ added, heavy ppt, filtered, added dilute HCl, not entirely soluble in it, but leaves a black residue, which is probably nickle and cobalt, (traces)

trace of manganese ~~contains~~ phosphorus

no aluminum " titanium

considerable iron, " " sulphur

Analysis of some hydrated Manganous chloride containing another salt, for Mr. K. L. Hickson

The substance contains a salt, besides the manganous chloride.

a considerable portion of the substance was boiled with H_2O to free it of the salt, the solution filtered and evaporated to small bulk,

The black residue which was insoluble in H_2O was treated with HCl and was insoluble in that.

The solution filtered, & treated with H_2S, no ppt

another portion treated with NH_4Cl, NH_4OH, & then $(NH_4)_2S$

NH_4OH produced a ~~[illegible]~~ brown flocculent ppt, indicating iron.

$(NH_4)_2S$ produced a black ppt.

f. The filtrate from the $(NH_4)_2S$ ppt was boiled with NH_4Cl, $(NH_4)_2CO_3$ + NH_4OH,
a small white ppt was formed, indicates probable presence of Ba, Ca, or Sr.
To a portion of the filtrate, some $(NH_4)_2SO_4$ was added, no ppt.
To another portion of filtrate, some $(NH_4)_2C_2O_4$ was added, no ppt.
The ~~ppt~~ from the $(NH_4)_2CO_3$ ppt was digested in dilute HCl, evaporated, H_2O added, and to a portion of $(NH_4)_2CrO_4$ was added, produced a white curdy ppt, which indicates Barium.

The ppt from $(NH_4)_2S$ contains iron, manganese.
The salt is mixed with the manganous chloride in $BaCl_2$.

Analysis of a solution, containing Iron, Phos. Calcium, H_2SO_4 & possibly some other things.

Solution is clear, with a yellowish tinge.

HCl produces no ppt, but changes color to a yellow green tint, still clear.

H_2S water produces a ppt. sol. in $(NH_4)_2S$ X

HNO_3 & NH_4OH added to a fresh portion ~~and~~ NH_4OH produced a ppt, which indicates iron.

$(NH_4)_2S$ produces a black ppt.

50 c.c = 20 grams iron to be analyzed for Al.

Weight of platinum crucible 22.920

Weight of crucible, ash & filter & residue, 23.0524 grams.
22.920
0.1324 " diff
ash 0.0007
0.1317 weight of Al_2O_3

Contain 53.4 % al.

= 0.66 % Al_2O_3 in Ogden Ore.
= 14.8 lbs per ton.
= 35.2 lbs $Al_2(SO_4)^2$
= 20.4 " H_2SO_4

Total amount of acid consumed by the Al_2O_3 & Fe is 29.6 lbs.

Contains P. Considerable
Fe Considerable
Ca fair
Ti trace
Al. fair
As. trace

Contains H_2SO_4

Qualitative analysis of mineral
given me by Mr. Edson

Ores sol in HCl

H_2S produces a brn ppt which on
digesting a portion in $NH_4)_2S_x$
does not give clear white filtrate
but a cloudy turbidity
decided white ppt with $(NH_4)_2S_x$
deposits insoluble residue in
dilute HNO_3
is a complete solution;
The portion sol in $(NH_4)_2S_x$ on boiling
with HCl, gives a brn ppt.
On addition of NH_4OH to solution in HNO_3
a blue coloration is produced.
indicates Cu.
On heating gently, appt comes down
which redissolves in sol of KCNS.
ppt from $NH_4)_2S_x$ is completely sol in
Na_2S.

Filtrate was boiled to drive off
H_2S gas, added NH_4Cl + NH_4OH.
NH_4OH produced a bulky iron ppt
which was of the green modification
added $(NH_4)_2S$ solution, gave a black ppt
in a compound sol in dilute HCl

On adding KCN to copper flux
a red [illegible] appeared, indicating Cu
[illegible]
arsenic
copper
nickel
aluminum
cobalt
iron
[illegible] of [illegible] which seemed to
indicate [illegible] gold or platinum.

77.6
5.8
2.58
1.548
1.290
24.444
1.222.4
1.2%

Standardization of Cupric ferro
Cyanide Solution

10 cc used.

6.2 − 7.4 = 1.2 cc = 10
cc cupric ferro Cyanide

Standardization of KCN for
Ni.

1/2 gm Nickel Ammonium used,
contains 38.46% Ni.

192.3 mg Ni

18.2 50.8 = 32.6 / 1.2 31.4 = 192.3 mg. Ni

31.4) 192.3000 (6.12.4
188.41XX
390
314
760
628
1320
1256

1cc = 6.12 mg Ni

Analysis of a sample of Burns Ore, found at Upper High Bridge, track on
has blue streaks in an otherwise light grey rock.
Burns thinks Blue is due to colorty

A solution of it in H cl, was given to me by Mr Edison, for Qualitative tests. The solution was diluted & treated with H_2S, which separated white sulphur. Indicates Fe in 'ic' condition.
Solution filtered, & boiled to expel H_2S, & treated with NH_4Cl & NH_4OH

Analysis of a sample of Burns's ore, found at Upper track at High-Bridge, has blue streaks in it, remainder is whitish grey color,
Burns thinks Blue is due to colorty

Ore digested in HCl.
residue after evaporating, was digested in H cl, & evaporated to dryness, to render silica insoluble.
Then redissolved in H cl, with large ex of H_2O, & treated with H_2S produced a separation of sulphur, & a dark ppt.
which is sol. in $(NH_4)_2S_x$.
To remove any Cu that may be present, ppt is boiled with Na_2S solution,

On during H_2S from filtrate
+ adding NH_4Cl, + NH_4OH, the
NH_4Cl NH_3 ppt of alumina, instead of
iron, as usual.
After a while, a little iron came down
The $(NH_4)_2S$ ppt was nearly soluble in
dilute HCl, leaving only a slight
residue. It contains Ni or Co, or both
The filtrate, having the dissolved sulfides
neutralized by 2x H_2S, + a portion
treated with H_2SO_4 produced no
ppt, no Barium + Strontium
a larger portion treated with HNO_3
boiled, + tested for Barium salts.
Contains Iron - does not contain
no zinc - Chromium -

000156

Analysis of a sample of reference
Pyrrhotite received from Mr E.
Its digestion in HCl aftwards
changed to a chloride
H_2S produced a turbidity, & also
a deposition of sulphur.
Evaporated off H_2S, added NH_4OH & NH_4Cl
The NH_4OH produced a ppt
added $(NH_4)_2S$:
ppt dissolved in HCl left a black
residue, which was dissolved in
aqua regia, to get rid of sulphur,
and reprecipitated.
The solution had H_2S driven off,
& was tested
contains fe, mg, ~~trace~~, al, mn, ~~mn~~ Co
H_2SO_4 gave no ppt of Ba, Sr, or Ca
Contains ~~trace~~ al
" " Cr

The H_2S ppt was redissolved in $(NH_4)_2S$ with
addition of sulphur.
Contains
iron much
nickel
cobalt } about 5%
manganese, small
magnesia
alumina
trace of one of copper groups

determination of Au of 5 - 15 cm
[illegible] reduced by H_2O_2 after
incineration.

Weight of Pt. crucible 22.8434
22.8645
22.8440
3) 205
41 mg

1 - 15 cm paper, ash = 4 mg

$BaCl_2$ KCn

$2KCn + BaCl_2$

$= 2KCl + Ba(CN)_2$

130) 207 (1.6
130
770
780

130) 390 (1.8
130
130
130

$Au(Cn)_3$

2 grams gold hydrolyzed = 3.8

90.0

KCn 3 - NOH

26
52
65
2
130

137
35
31
207

203

[illegible] dollars =

[illegible] 50% at [illegible]

$[illegible] cts [illegible] cts for dollar of [illegible]

materials.

for [illegible] dollars for [illegible] 3 cts for [illegible]

[illegible] for 10 dollars.

Oxalate of Cobalt

$C_2Co'O_4 + 2H_2O$

24 59 64 36

64

36

59

183

59) 183.000 (3.1
177
6 0
5 9
1

183) 5900.000 (32.24
549
410
366
440
366
740
732

= 32.24% Co

Oxalate of Nickel

$C_2Ni'O_4 + 2H_2O$

24 59 64 36

183) 5900.000 (

32.24% Ni

250 milligrams diluted to 250 cc.

125 cc. for test

4.03 mg = 10.6 cc

Assay of a material received from F. Wagner of Ch. Phen & Dist., which is used as a substitute for Borax in Pickling.

I.D.S. white powder, resembling Borax

Sol. in H_2O slowly in cold, in H_2O at boil but in dissolving strong effervescence. On addition of HCl, produces no ppt.

H_2S produces no ppt.

pH = 9.4 to H_2S, boil, no solution, probably a trace of iron salts.

(When the powder is heated in a test tube, this will complicate instance)

(flame reaction indicates Na).

No Ba. trace SO_4

No Ca gives very strong reaction with

No Sr $O_2(NO)_2$ indicates grossness Ca.

" Mg

" K is cyanide of Sodium

" Li

23.8 34.4
34.4 45.2

10.6 10.8

10.6 cc of permanganate sol. = 4.03 milligrams of Fe in Fe C_2O_4

1 cc = 0.38 milligram or 0.00038 gm

29.6
70.4

40.8

57 .9990
.1998 grams

40.8) 0.1998000 (4.897
163214
3660
3264
3960
3672
2880
2856

1cc = 4.897 mgm

1 Cu

5 gram ore / 100 cc.
100 cc used in each test

43.4 cc
1.25 %
2.0.627 = 60.7 = 12.5% cu

2 5 gram Cu

2 Cu 44 = 110 cu

✓ 5 gram
2.3.8
56.4 110 cu.

4 – 5 gram

45.1 98.2 = 7.2 = 24.1
24.1 = 84 = 6000 = 6.2% cu

5

6.5 = 23.8 = 23.3 = 2.4% cu

✓ 6 – 1.25
24.2 83.0 = 58.8
= 12.2% cu

7 – 1.25
3.3 48.9 = 45.6
9.4% Cu

8.
110 cu

1 cu 11.383 585 = 200

2 cu 11.7267

6. Roaster
2 grams used

7 2 grams used

8 2 grams used
64.200 No Cu

9 5 grams used.

10 Roaster 5 grams used

11 5 grams used
Certificate (Co)

12 5 grams used

13 5 grams used.

Weights of Pt. Strips

~~# 2 - 43.0~~

~~# 4 - 31.5~~

~~# 6 - 30.00~~

~~# 8 - 35.00 mg.~~

~~# 10 - 37.75 mg.~~

1 - 11.325 - 11.337 = 9

2 - 13.1595 - 13.168 = 10

3 - 12.984 - 13.000 = 11

4 - 11.337

1680
15950
98

337
325
1.2 mg. 16
78.7
1574
787
10.44.4

78.7
4722
787
9.787
12.59.2
.63

Cu.

7.63.2 . 75.0 = 86.45 mg.

10 45.5 . 63.2 = 69.68 mg.

11 84.8 . 86.3 = 87.67 mg.

12 37.4 x 45.5 = 32.0 mg.

13

2.3.22
3.484
15

4(997

42 77.1 - 29.37.4

42
554
8.4
6315

29
8.1
11.8 3.937
31496
3937
2.9537
46.45.66

9.6.3
8.6.8
11.5
258
1270
258
2.5.6.70

11.336

(3.500 - 250 mg. Cu.

63.5) 250.0000 (3.93
190.5
59.50
3715
2350
190.5
4650

8.1
3.9377
3937
31496
3.48.8.97

1.7.7
3.937
27559
27559
339.37
6.9.6.8.49

Experiment on analysis of Ni.
by Colby Uniform Hydrate method.
solution of decidedly clear solution
H solution = 500 cc + 250 cc [illegible]
Ni obtained [illegible] of Ni by Colby method
5000 cc

12

# 12 5000 cc
105 = 3750 cc
75

570 : 2 [illegible]

570) 750,000 (1389 grams
570
2100
1620
4800
6320
4800

= 1.389 grams

14 2 grams = 2.94 %

37.5 cc – 1500 cc
225 cc

375) 22500.00 (

34.7 × 2.0 = 7.3 cc
225 : 375 :: 28.74 : x
3.937
11811
27559
28440 milligrams

1.200 grams

800 grams = 1500 cc

6.6 : 8 : x : 1.00

8) 66.00 (8.25
60
40

22800
8967
8.7 mg
2.2
6.6 g

15 2 grams = 1

415 - 140cc

275 cc | 415 | x 2

Cu for 275 cc
90.6 - 98.9
2.4 34.7
2.4
275 cc = 12.06 % Cu
3 2 3
40.6 cc
22.909

Pt. Crucible
22.8520
22.9055
.0535 mg.
4
.0495 mg.

= 2.3 % Nitrogen
.06

Cu Iron
6 51 %
8 7 %

Ni
22.883
22.894
11
7

16 2 grams

470 - 120cc
120
350

45.4
0.8
54.4 cc
.937
15.748
17.685
3937
60.62.98 mls.

= 4.07 % Cu

22.862
22.8865
.0245 mg
6
205 mg = 21

= 1.4 %

Iron

17 2 grain

425 - 75 cc

350 cc

60.8
60.8
50 cc
3.04
31784
19865
2.3.0434 mil

= 1.49% cu.

ni. for 1 350 cc

= 0.40% Ni + Co

Weight of residue = 8.5 mg. for 350 cc

0.52

cu Iron Ni

22.8895

18 2 grain

315 - 115 cc

200 cc

66.4
94.5
7.17 cu = 5.55% cu.
.937
35.438
5.559
.937
3.4712 3 milligr.

22.8895
22.8845
15.5
u
11.5 mg. nickel

0.81

Iron

19.

2 5 cc.

415 - 105 = 310 cc.

= 149 x mg. = 9.8% Cu.

22.877
22.893

016

1.2 mg = residue

0.8%

Solution of CP Electrolytic Copper for standardizing N/10 solution

Weight of Cu 0.7825 grams dissolved in HNO_3, diluted to 7825 c.c.

Water Analysis for Mr. [illegible]

Determination of Solids

Dish & residue 101.943 grams

Water & dish 253.500 "

Water by diff. = 151.557 grams.

Evaporated & dried at 100°C

Residue & dish weigh 101.950 grams

Residue weighs 0.007 grams =

0.00462 % by weight of total solids =

Total quantity of solids per gallon = 2.69 grains.

Water has a straw-yellow color which is due to suspended matter, the majority removed by filteration.

has a disagreeable taste

has a slight acid reaction

200 cc for cl = 4 milli cl.

200 cc " H_2SO_4

250 cc " Ca & Mg. no S.

One american gallon = 8.33888 22 lbs

1 lb. avoir = 7000 grains

1 gallon therefor has 58372.1754 grains.

50 mil NaCl = 39.32 % Na (meaning) =

60.68 % Cl.

28.000 cc $AgNO_3$

59.4

21.4 cc =

1 cc = 14.45 milligm Cl.

10 cc + 90 cc H_2O =

1 cc = 1.445 mill. Cl.

$$\begin{array}{r} 59.8 \\ 59.6 \\ \hline 2.8 = \end{array} \qquad \begin{array}{r} 2.8 \\ \hline 11560 \\ 2890 \\ \hline 4046.0 \end{array} = 4 \text{ mill. Cl}$$

$$60.68 \,\big)\, 4046.000 \,(0.06$$
$$\begin{array}{r} 36408 \\ \hline 40520 \\ 36408 \\ \hline 41120 \\ 36408 \end{array}$$

No initiation

Contains 1.94 grams Na Cl per gal.

" 1.05 " suspended matter per gal.

Is potable after filteration.

Contains 39 milligrams of Ca + Mg carbonate per liter =

Contains 5 grams per gallon of Ca + Mg. carbonate

Weight of pt Crucible

22.839 grams.

10 filter papers incinerated.

8485 — 40, 16

8390 — 12, 32

0.095

Weight of crucible & incinerated Ca + Mg ppt

22.8405 — 6.66 / 5

22.8465 — 0.1.5.4

.6 mg

1/5 mg of Ca O + Mg O

51 × 40 : 92 — 9.7

35

(48) 460 (9.7) — 38.8

432

280

.101 7000
.059 2.
.10
1.4
1 3.4

1 liter milk, 15 400 grams
1 " " 1 000 000 mil. gm

1 mg. = 0.0154 grams
39
1386
462
.6006 grams per liter
8.3388822
6006
2.2
50.0332932
300332932 00
5.0083,3,24,49,32

pl circle 22.8465
22.8550
0085 mg
.425
2125
3400
425 : 350 : .85
350) 3.125 (103.2
350
1125
1050
750
10.32 mg
10.32) 2000.00 (193.8
1032
9680
9288
3920
3096
8240
6
0052
78
416
364
.4056

193.8) 100.0000 (.516
96900
3100
1938
1620

Experiments on new method of [illegible] Ni.

In 50 c.c. Pure Nickel Anode is dissolved in HCl & ferric [illegible] added [illegible] & [illegible] added.

Experiments on new method of nickel determination by Thomas Moore
in Chemical News Vol 59. 1889-1. Page 292 1. June 21. 21

Cobalt is not determined with it, & should be removed first.
Copper must also be removed. A measured amount of the slightly acid HCl solution, a solution of Sodium pyrophosphate is added until precipitate ceases to form, & then a slight excess is added, (the acid till ppt is redissolved, but I have been mistaken to redissolve the ppt, even on adding 1 quart of solution of sodium pyrophosphate, to about 100 c.c. of HCl solution.) Ammonia is then added drop by drop, till the ppt. dissolves, & excess added to render the solution blue, a measured quantity of ferric ferro cyanide is then added, which is equivalent to a known number of c.c. of cyanide solution

+ The solution of Potassium cyanide
[illegible] standardized, [illegible]
added. Till the yellow color is [illegible]
If it is [illegible] in a ~~[illegible]~~ [illegible]
drop, the last drop can be caught at
the right time.

Experiments of Pfiff: of Cobalt
H 1.
Page 151 - Special method
Chem. Analysis by M. A. Jewell
~~Solution for Ni determination used~~
Ammonia added.

12 2 grains

14 2 gm

20°° cu S.U.

63.4

Cuadr. mayor 22.888

15 2 grams

20cc Cu Sub. 21cc KCN.

5 grams

20 2 grams

When HCl was poured on roasted ore, gas off a gas, like a carbo. etc.

50.8 55.2 = 3.2 cc for Cu of 5 gms =

50.8

4.4

= 0.3134% Cu 1.2

3.2

4.897

3.2

9794

14691

15.670.4 mg cu in 5 grams

3 grams

390 — 2.15

Weight Crucible 22.858

22.8707

13 10 mg

1.5 3906

7.5 50/754

1.0 1.25

21 3 grams / 7 grams

55.34 7.6 64.9 - 92.3

12.3 4.897 64.9

13.7 28.0 27.4

1.4 39176 1.4

= 2.82% Cu 39176 28.8 cc

9994

141.0336 mg Cu in 5 grams

0.8% Mic

320 cc - 150 cc

22.8707

1.29075

30x0

107

6.70

37

4 | 33

8

3

4 hy

22 5 grams / 2 grams

3 grams

340 cc 150 cc

2 grams Cu 9.7 cc

27.7

22 c.c.

4.897

9794

9794

10.7934 mi Cu

120 : 10.8 :: 100 : x

20 / 1080 (.5%

23 5 grams
2 grams

3 grams

24 5 grams
~~2~~ grams

19.8 - 56.4 = 22.6
41.2 = 3.07 %

31.4 cc = 3 grams

465 cc - 3 grams
220 = 245 cc remained

22.9075
22.910

2.5 mg -

3000
30/250

30 100 245
26 12250

465 : 5000 245 : x
5000

465) 1225000 (2634
930
2950
2790
1600
1395
2050
1860

131 1 gram

Cu orig - 56.4 - 62.8 = 6.4

1 gram 4.897 1.12

5.2

9794

= 2.54 % Cu 24485

25.46 44

5 grams Dupal for pt

.7

2 gram

22.9105
22.9182

7.4 mg.

20) 77000 (3.85
60
170
160
10

8

2 gm

30.6
39
1.4
1.2
7.2

4.897
7.2
9.784
34279
35.25.94

20) 35.2594 (1.76.29 % cu
20
15.2
14.0
1.25
1.20
.57
1.74

12

2 gm

.34% M

22.9182

22.925

20) 6.8000 (.34

60

6.8 mg

15

2 gm

22.925

22.9305

.275% M

5.5 mg

50/5.5000

.275

22

2 gm

5 - mg - diff

2[illegible]) 5.0[illegible] 12 s 24[illegible]

23

2 gm

Cu. 41.5 × 8.97

53.5 108

120 391 86

1.2 48970

10.8 528886

(2.0 x) 52.8886 (26.4443

40

128

120

8

10.44

(0.0950) 1.0000000000 (10.44

95 58 1.1.1.1.1.1.1.1.1

04200

3.8032

3.8 gm

10.44 g

3 12.48 gm

6.96

.037296 gm H per amp/hr

22.8850

22.8853

20) 53 cm (2.65

40

130

no ppt in adding $(NH_4)_2S$

no ppt in adding ammonium acetate

ammonium

Notebook, N-88-03-15.1

This notebook covers the period March 1888-April 1889. It was used by Erwin Von Wilmowsky for rough notes and calculations regarding chemical analyses and the preparation of chemical compounds. Included are analyses of chemicals ordered for the laboratory and assays of copper and nickel ores. The prepared compounds were designated for use in various experiments, including phonograph cylinders and insulation. The book also contains scattered entries relating to battery, filament, insulation, and chemical ore separation experiments. There is a table of contents at the beginning of the book. The spine is labeled "57." The book contains 186 numbered pages. Nine loose pages of correspondence, notes, and other material relating to Von Wilmowsky have been inserted into the book.

Only the material pertaining to battery, filament, insulation, and chemical ore separation experiments has been filmed.

1) Carbon Filaments from Ulmic Acid: dist 106 g dist + Carbon 193 g + H_3PO_4 233 g heated to 320: bubbles, cane got slowly, it is gel soluble in water, heated more. The substance blown up, is flexible & flexible also, easily, in soluble in water. Weight and Dec 12 loss 61% of 127% i.e. 58%.
The substance is transparent, very shiny.

2) dist 106,5 + Car 213,5 + Glycerine 253,5 + 209 Bar Ac cryst heated quick to 370° C. Threads made, soluble in water deliquescent.

3) dist + Car 179 g + Bar 186 g

Tungsten Electrodeposit

Tungstate Soda 3 oz + 16 oz aq
mixed by clean $K_2S_2O_8$ Solution
heated by water, then (1:5) Dil. HCl,
water again and redissolved in $K_2S_2O_8$ Sol
in excess of final) + 25% more.
Wolframic Acid + ¼ pt NaOH melted and
electrolysed with Carbon Electrodes.

White Deposit Ammonia
with Carbon Electrode
electrolysed from out
c 30° F Reduction of temperature

3 Filament samples: A Melasse Acid (Brown Ac) 41d + Carbolic Acid 5% heated 1 hour 190-160°C until gelatinized, loss 23% (Carbolic Ac and water). tough and flat.
B 110d Glycerin + 20d brown Acid heated in a double bottle until as evaporated
C Sugar + Carbolic Acid heated in open air.

2 Sugar + 2 Glycerin (distilled bp 290-360°) heated to 240°C until insoluble in CHH gelatinized on cooling with gas bubbles remaining.

Glycerin 4 lbs were distilled so that nothing could flow back in the still and a 70% nearly colourless distillate obtained at 290°-320°C 10% at 240-290° and the rest with temperature quick rising to 360°C very dark coloured and much decomposition going. The residue gave good filaments of more strength than the hydrocarbon but with much ashes too.

2 Sugar + 1 Distilled Glycerin heated only until insoluble in aq ether, a cylindrical condenser was used & good filaments if dried slowly and heated in dry CHH gas and carbonized in CHH ~~gas~~ too.

Allways (except one case) there remained gas bubbles in the mixture if gelatinizing took place and gelatinizing came even with much 2 Naphtol or Glycerin or both present (fr 1 pt to 3 pts Sugar remaining) and sometimes on cooling even.
Then the gas escaped even when cooled down so much as to 160°C.

The Sugar + Carbolic Acid + Glycerin ~~evaporated~~ partly and heated to 240° and then in Papin to 340°C and evaporated at common pressure from 190 to 24 pts gave a mass

quite free from bubbles and entirely
dangerous good for filaments.
but after carbonizing as well as
before the ~~carb~~ filaments were
more brittle as gelatinized
Sugar - glycerin.

1879 Filaments:

The best results filaments were
obtained from Sugar + glycerin + ClH.
Raw Sugar was omitted and the
Residues from making Chloroform
both by ClH as well as by Soda
were evaporated slowly to dryness:
these Substances gave good and
strong filaments without bubbles.
Glycerin simplified [illegible] in presence
of a Residue which was useful
Glycerin + 10% Silicon Dioxide
Lanolin Oxide, Lactic Acid Residue
Dioxide.
Industrial Lanolin saturated with SH_2 (A ab
Tarbs c 60 [illegible]) and evaporated.
Sugar + Glycerin heated (1 : ½) until insol
in water, also and during 3 weeks settled
down to a brown tarry syrup once more
body to the orange liquor contain-
ed residues and better filaments.
But Bamboo fiber dipped in gly-

cem and heated [illegible] Ac
exp the air [illegible]
with glycerin saturated with Cl
[illegible] pressure with the above
[illegible] dilt under [illegible]
[illegible] to be the best [illegible].

[illegible] to dell the big [illegible]
carbonator [illegible]:

Rosin 225 lb (Ca O) heated
Asphalt 4 lbs heated
Linseed Oil (strongers mixed with
the above equal parts gave [illegible]
[illegible] strengthening [illegible]
[illegible] of the mass of [illegible] 225°F.

NB. [illegible] Sheet
[illegible] Stearates take [illegible]
[illegible] dry Cl_2O_3 gas.

Pipe Filling Insulator:

1) Stearate of Lead from Stearic Acid heated with ½ Litharge made:
2) Stearate of Lime from Stearic Acid 100 g + Ca O C.P. 20 g heated, made.
3) Stearate of Lime (soluble in Turpentine) heated with Rosin Oil 2 min until combined to a soft gelatinous brittle mass
4) Stearin Pitch Jensen and Marshalls Stearin Residue from Morris or Motts Co fried.
NB. both carbonate well for filaments, the Pitch contains small amount of Ashes.
5) equal parts boiled Linseed Oil, Asphalt, Lime — Stearate gives good mass.
6) Lime Stearate will not ~~combine~~ mix with Linseed oil and the basic lime Stearate not even with Rosin Oil.
7) Rosin oil + 30% $Ca(OH)_2$ will not mix well because $Ca(OH)_2$ was sieved but rather too lumpy. to be tried the

paint mill for this purpose.
pag 72

China Cements

Several clay mixtures tried.

180 Kaolin
90 Feldspar
90 Silica
90 Na silicate Syrup

} stands well in fire, shrinks c 7% diam after wash c 9 tons pressure psi □".

Vitrite white, non porous, polished in ag 12 hours and tested stands sufficient resistance, does not flash more than air does.

As Na silicate was replaced by burned Gypsum the mass was porous. Stood well (Properties 88.190.26.12.8) Dicalcium silicate was produced by oyster shells.

Flux spar + Gypsum equal parts formed an easily fusible glaze.

Oyster shells tried. Fire Clay makes the mass more manageable, avoids fissures (50 25 12 12 + 4% ag) but requires more Feldspar.

tried 150 Kaolin 100 Feldspar
90 Silica 90 Na silicate Syrup
150 Kaolin 25 Feldspar 12 Silica
12 Oyster shells 12 Fire clay 8 ag

Filaments

180 g. Glycerin freed from Copper by SH_2 were heated 7 hours with c 380 g S_2Cl_2 dropping in at 130-140°C, then 3 hours 180°C boiled with a thorn condenser, cooled, filtered, evaporated left good Residue for filaments, stronger but not so fine as the Residue from distilling the Dichloridrin.

The latter residue ~~good~~ is better to heat bombax fibre in, with the purpose to fill the pores and give shiny surface.

Programme:

to test carbonized and non carbonized Bamboo filament and raw fibres under vacuum and then pressure in the Silicate paddes and the Glycerine sulphur residues not above c 240°C

Ditto with water + Trace Carbolic Acid

Ditto with the old Molasses Acid + Urea.

Bamboo fibres were heated under pressure in Glycerin: carbonized into tar not dissolved in Glycerin

2/in Carbolic Acid: all dissolved temperature was 1 hour c 900°C

Anthracite powder heated ditto with Phenol & Naphthal, Anthracen was not attacked.

China artists glazed with pure Feldspar burned the same time with the mass. The half dried cylinders dipped in the glaze mixture made with Gum Arabic. Result good, does not more than 1/4 so much as air float. Resistance of the whole cylinder was 50,000 to 500,000 ohm. Ground surface quite white and hardly porous at all. Edges partly melted, mass proved best if taken as 1 pag 56 (180 : 90 : 140 : 90).

Potassium Silicate Syrup Dido 300° C lost 60% aq and is then easily pulverisable.

Potato silicate crystals Dido lost 50% aq.

Kaolin was previously heated to redness for 2 hours and lost 1.8–15% aq, was powdered before heating. Good to reduce shrinkage.

Oyster shells lost on heating 2% formed Kalk with aq an not attackable paste, not much as a flux (an account of the fluoride lime in it).

Analysis of Lime for Bottlers.

SiO_2, Sugar, Fe sulphate were added to Baltimore Solution and on heating of the solution more than usual observed. Pencil marks gave the same result. Sh and As 10 mg to 20 g made the time boil in c 15 Min. Lime Fe nitrate with Lime was not tried.

Therefore Sh & As to be removed from the malt. Lime by a cheap preparation made as [illegible] Sulphur Solution of MgO_2 & Sugar are mixed with precipitated chalk salt dried slowly and gradually are mixed all water gases away [illegible] Hot. Equal weights of all the mixed, MgO_2 may be evaporated dry and gradually heated mixed only MgO_2 is left in fixed state and no more in compounds.

For Analysis of the Lime Under Marsh Apparatus is useless for quantitative work.

To be take 100 lb dissolved in 2 M H_2SO_4 + 5 times water + 5 % Cr_2O_3 (C.J. Calculated) according the formula $Zn + \frac{3}{2}Cr_2O_3 + 2H_2SO_4 = ZnSO_4 + Cr_2(SO_4)_3 + 2H_2O$
60 : 100 : 2.98

The "American" Chromic Acid contains 85 % CrO_3 we have to take '80 k instead of '67 pig 24

Chinaware Crucibles

Gypsum (burned) was tried as mud as c 20 % it made a solid mass only if a certain high temperature was not exceeded. At higher temperature the mass became quite porous.

With a red hot Rabbit and high pressure, full force of one man with long lever pipes on the big press (c 8 ton for plate of c 57 ") no shrinkage was observed, with the small hand press c 1½ %.

The Glaze was well when made 40 cc of 5 % gum Arabic 60 % Feldspar 6 % Phosphate of Lime Precipitated.

The mass was for a full yellow heat nearly too soft if made 150 Kaolin 100 Feldspar 90 Silica 90 Silicate Potash Syrup. (= 3 % 2/10 Dried 20 % C) and.

Bottle was 45 instead of 90 Silicate. No porosity in many more who then absorbed.

Burnt & precipitated Chalk to be tried. Magnesia etc. etc.

H

Analyses

Magnesium Chloride + Chloroform and
43.5 g dry + ($MgCl_2$ + 7H_2O) 1125 - 50 g
for remark, Ans as the Chlorine in other Lines: 618.2 g
Dish + Dish = 1542 g ∴ 3 oz $MgCl_2$ gotten
by heating about 4 ounces crucible until [illegible] had ceased
and no Chlorine vapours. Delivered to Mr Kenelly.

Chromic Acid produced (Courtesy Sydney Exposition)
from Theorspar, Lead Chromate, fig on strength
Sulphuric Acid (3 : 4 : 5) mixed in lead
Jar and the red gas (CrO_2Cl_2) + sufficient chlorine
to form $CrCl_3$ + HCl + H_2O. Gentle heat 1 : 1 : 3 fuming.

Chromic Acid Commercial Analysis
200 g German and American take 2 litres
spec wgts 1,126 and 1,130
made gold colour by wgts 55 cc and 65 cc
Ans aq. German precipitate Fe_2O_3.

$FeSO_4$ Sol made as ·507 N
15.7 cc = 7.95 N ≡ 3 g $CrCl_3$ Sol 20 g = 7.7 N Cr Sol
(therefore Fe Sol really only ·492 N. Average
taken in the following ·500 N.

German 20 cc used after dilution (1 : 10) 25
for 10 cc Fe Sol therefore ·247 N is the
German Cr Sol or 5 g Commercial CrO_3
contain ·247 = ·0619 eq g ≡ 2.06 Cr O_3
therefore 41.2 % Cr_2O_3 Standard
(≡ 28.8 % Oxygen)

Ames 2 N used 10 cc therefore 49 N
5 g ≡ 7.22 4.07 therefore 81 % CrO_3 (≡ 19.48 Oxygen)

300 g Cr SO_4 are contained in each cylindrical
barium cell. 1 Amphora ≡ 1.23 Cr O_3 Standard
300 × ·81 = 243 g ≡ 200 Amphora

Sulphuric Acid Standard S.G. 29 % SO_3
Free Acid for 1 % G. 140 cc Normal Ans 17 % SO_3
Ans 166 Normal g
therefore free SO_3 G. 24 % contained 5 %
Ans 16 %

Chromic Acid Heated gently and left Residues
German 66 % American 62.5 %
Salts hailed out for Residues (Potash) G. 11 % Ans ½ %.
N.B. ∴ 5 % contained SO_3 ≡ therefore only 11 % K_2SO_4
Arsenic found trace in Theorsar (4 %) and trace in German
(less than ·005 %) (very sh.)

Iron German $\frac{1}{10}$% American .015% Fe.
loss of 200° German 18,5%

German
~~Fe~~ O_3 .15
Cr_2O_3 41,2
Al_2O_3 11
~~Fe_2O_3~~ 24
CaO 29,3
MgO 1,35
MnO none
H_2O
Lead Chromate 100

American .02
81

$\frac{1}{2}$

$\cancel{17}$ 9,5 SO_3
$\cancel{1,5}$ 9,5 H_2SO_4
.003% As_2O_3, no H_2S
100

Pt Ore 22,640 } boiled with Aqua Regia
+ Au Cl_3 25,680 }
24,320

1326 $\frac{3}{4}$ 44,2% ~~loss Pt~~
61,5% ~~Pt~~ alone
5% loss of Pt by Ether vapours

Resin, Resin Oil I–III fractions, alone and with Stearic Acid were saponified by powdered CaO, ZnO, MgO and 10–20% Linseed Oil added.
This pulverpapaches were mixed c 1:3 with Asphalt, Coltarpitch, and Insulation, and c 10% Bees wax added
and the boiling point raised in this way.
But the masses were deemed to be less brittle below the freezing point.

Then Tannyl Acid (from Crude Palm oil) is to be substituted for Stearic. Sulphur is to be used and continued boiling.

Asphalt to be worked partly in Asphalt Varn (see Watt's Dictg) by heating 20–50 hours to 250° C.

Syrian Asphalt take $\frac{3}{2}$ $\frac{2}{2}$ $\frac{8}{140}$ Stick 9,8

Small Thermometer 9,2 hog 300° C = 1" from end
big " 9" from end
Heated 3 hours Max Summa 260° loss 8° = 5%

Temperature above = nearly 300° C.

Chromate Bath

Bichromate Soda 2 ℔ and Water 300 ounces 106
Con H_2SO_4 and additions of 21 % to equal Chromic Acid as this little contains 81 % CrO_3 and the formula 67 % Cr_2O_3:

Bath Solution 5 Chromic CrO_3 + 12,5 Con H_2SO_4 + 40 aq therefore to be replaced by

80 aq + 12 ℔ Bich Soda pure + (154+72 = 312 ; 17,2 = 66) Con H_2SO_4

try if this crystallizes

6 ℔ Bichr Soda 2 ℔ H_2SO_4 + 3 ℔ aq does not crystallize

100 lbs Chromic CrO_3 = ℔ 316 are equivalent to
121 ℔ Bichr Soda + 40 lbs Con H_2SO_4 add price ℔ 11,30
as the chromic crystals contain 17 % H_2SO_4 174 are to be added thus is ℔ 11,47.

480 − 64 = 416 ℔ Bichr Soda Con + 555 cc Con H_2SO_4 (50 spec 1,244 = 35,6 %) + 2277 l aq = 1139

or practically 416 ℔ Bichr Soda + 1 l aq

of this solution take 25 cc and to 500 cc

27,2 cc ≡ 20,7 cc ½ N Fe : (5/8 N Cr 12,5 cc)
≡ 9,40 ½ N Fe therefore Fe Sal 49 N)

then 27,2 cc Cr ≡ 10,14 N Fe : Cr Sal 27,6 N

Spec gravity Analysis 1,235
N Sal ≡ CrO_3 10,2/2,100 = 12,42 % l CrO_3
or 1415 × 20 = 283 % Sulphuric
283 : 416 = 68 % Sulphuric Con Bichr Soda
$Cr_2O_7Na_2 + 2H_2O$ contains theoretically 67,1 %
Sulphuric Acid only trace

Proportions are therefore

6 lbs Bichromate Soda	60 ℔	
15 lbs H_2SO_4	15	
40 aq	75	

equivalent to

5 lbs Chromic Acid	80 ℔
12½ lbs Sulphuric Acid	12 ℔
40 lbs water	92

75 % : 92 % = 81 : 100

If the above solution (500 cc 996 cc were left after filling Bath to mark, therefore 2564 cc were used, containing 75 % = 250 % or 81 % Chromic Acid

and 25,2 % = 645 g = 1,42 lbs 65 % H_2SO_4

2,2 oz Acid. Sol. 3,5 ¢ carbon 170 g = 1,94 AH
1,42 lbs Sulph. Ac 1,5 ¢ = 138 AH

Battery Zinc (½ plate = ½ lb = 6 ¢)
à 1,2 ohm Amp. Hours = 190 AH
meaning and 70 % of water
i.e. 0,4 ¢ for water
Amperage 4 ¢
5 ¢

Since 12 ¢ for 110 Amp. hours of Zn and H_2O only 20 % are left

Accordingly the figure Zn or H_2O be left
11,5 ¢ for 143 Ampere hours used 1,4 volt
19 % Wastage = 3,75 ¢ Zn & H_2O
Therefore 1 HP = 43 ¢ is all to be consumed
or 54 ¢ if only 80 % of Zn, H_2O and voltage is used

N.B. Ah consumed of the Jan 2564 °C of 1,240 sp. gr.
is 3180 g ~~carbon~~
11 oz Bichr = 6,9 ¢ = 172 Amp. H.
1,3 lb Acid. 1,8 ¢
½ plate Zn at 6. ¢
147 ¢

one Jan measured direct converted to Hanack 2420 °C
= 2420 . 1,1359 = 2,75 quart ¢ = 3000 g = 6,6 lbs
Bichr: H_2SO_4 : aq as 6 : 15,5 : 40

as 9,75 % : 25,25 % : 65 %
293 g + 756 g + 1951 g (since 3000 g)
= 10,3 oz + 26,1 oz + 68,9 oz (105,3 oz)
6,4 ¢ + 1,6 ¢ ≡ 199 g Zn H_2O = 162 AH
Zinc plate = ½ lb = 6 ¢
Since once filled 8 + 6 = 14 ¢ for 162 Amp. hours. Really it lasts about 20 hours = 45 Amp. hours
Remedy of the Zinc plates:
1) Mg in Acid; Mg H_2 (and casting with precipitated CO_2)
2) Sulphuric Acid free of Arsenic or Antimony to be used as from Poles a Nitrogen.
Consumed Battery Solution to be determined
The rest of Cu H_2:
This can be reduced by operating the motor so that a lower voltage will do, and increasing the diameter of the rotor.
Battery Leads 2,0 to 1,8 mm to the end (without increasing) (leading and returning as regulating lines)
Motor at rest ½ ω, while running ⅔ ω
Battery has resistance of 0,4 ohm. 0,3 ohm minimum, then in straight line increasing after 25 hours the end of life after 30 hours 0,2 ohm 15 ω and at the last is 0 after 34 hours 25 ω
Motor: (a) Battery ½ volt
(b) Battery ½ volt
months = ⅔ short lost 20 to 1,7 volt means 20 % decrease of power and 25 % increase 10 % decrease

To try: $HNaSO_4 + Na_2Cr_2O_7$

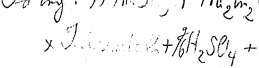
x Isomalt + 7% H_2SO_4 + 6% Bichromate Soda (heated to ...)

Electrical figures from last page show Alch. Chalk 25 lamps as standard time point as the proportion does and any more ~~[illegible]~~ will show A off (this comment) with 75 w Bottle-u and .33 Motor-resistance and 1,8 volt Battery – and .44 Motor-Electric Furnace. All only will work is 3,22 Amperes

multiplied by .44 volt = 1,64 watt

the Lamps map dar 2 49 watt

the Motor Battery and the ...



The original amount of Amperes is

N.B. Tar and Carbon gave 2 ... Exchange Jar. At first the preceding used less ... But stop for cheaper passed Carbon plates. – Bichromate Soda as above gives 1% Sur. Electrolyte place and about (½%) pure Hydrate and last 2% Sur. time.

The ~~[illegible]~~ of the scaling Motor resistance at full running at constant speed was as a average .66 w. ... end of ... is a account of variation ...

The cylinder ... 4¾" × 2" × ⅜" = 20 □"

4 Carbons ... 5" dipping in 1½" Depth ... 2 rows 1⅛" distant. Platinum – Carbon distance at the beginning ⅜ at the end ⅜ Surface 72 □"

At the ... the is 2,75 Amperes, after 25 lamp 2,3 ... 55 and 4 Dr. watt.

Try Amylsulfuric Acid in other I. Epharacids (not too high priced as Amylsulfuric is gallon (1 ℔) suggested by H_2SO_4 acids not ... on Amylic ...

Dichr. 535 g / 1225 | 10% Bichromate Soda of the same temp
" Bichr. 1258 | lost in the same time 13%
(1) 1213
(2) 45% = 6%
then 47 = 11%

Infusorial Earth Slake 679 g
Dried 654
loss 25 = 4%

260 g dry Bichr. + 756 g H_2SO_4 1,845 S.G.
+ 500 g Infusorial Earth dried and sieved

g become hot, smell of SO_2

27 g H_2SO_4 required more 12 g sieved not dried Infusorial Earth to give a sufficient dry paste

After preparation of Bichr. Soda 6 lbs + 3 lbs H_2SO_4 mixed by pounding and dried and thereafter separately 15 lbs H_2SO_4 + 7 lbs dried Infusorial Earth mixed and both put separately in air-tight bottles which must be dark tot on Infusorial Earth is heated in oxidising manner before.

Second Sample of Bismuth (Scotch)

[illegible] analysis [illegible] 12 [illegible]
[illegible] 2–2½ [illegible]
[illegible] 2½ [illegible]

The [illegible] of original [illegible] 55 [illegible]
[illegible]

819 g sieved Infusorial Earth heated
369 g heated in oven one hour
350 heated in oven two 5 %

(293 g Bismuth I (Philadelphia)
or 321 g Bismuth II (Scotch)) Bismuth dissolved in HNO3 and precipitated as basic nitrate
+ 200 g H_2SO_4

606 g H_2SO_4
606 g Infusorial Earth
(Both) 2 days (189 g flows 5°)
Will fill ⅓ of the space = 1900 cc

16 B. 6:15 p: 40 (see p. 84) from 19 hours only, instead 26 hours as 28 g with Infusorial earth only 17 hours. Water in left tube 6:45: 40 – 28 g Infusorial Earth.

Bath for 1951 cc aq (see page 85) 1 liter cell in

Chromate 3 g, Na_2CO_3 9 g + KNO_3 2 g.
Then 17 Cubic centimeters solution 1 hour
[illegible] gained 206 cc Chromate Solution, equal in color to 180 cc of 1 cc K_2CrO_4 Solution, which contains [illegible] Chromate Solution in [illegible] 1 % consumed. 14 Chromate Solution in [illegible]
Preliminary: Treated the same way once more gave 190 cc Solution = times 24 % of 1 cc K_2CrO_4 Solution
Summary: * 100 g ore will give 192 g Bismuth Soda crystal.

Theoretically is Cr_2O_3, FeO not = 224 4 Na NO_3 = 340
$2K_2CrO_4$ (= 3 [illegible]) : $Na_2Cr_2O_7$ + $2H_2O$ (= 29 [illegible]) = 100 : 26,7
Cr_2O_3 = 152 Na_2CrO_4 = 106

Then heat 224 g ore finely ground and sifted + same mixture of 106 g dry Soda + 300 g KNO_3 in porcelain crucible with oxidizing flame, stirring in water, add 3 Hydrochloric fuming, evaporate, crystallize and dry and wash in centrifugal.
164 kilos of 55 % = 55 % after 3 treatments and 309 CrO_3 found in Solution, this gives 1,68 (Bismuth Soda crystal) according to Abraham (the above only calculation text).
309 g CrO_3 = 309 Cr_2O_3 1,64 + 309 = 2,49 not all the chromate can be left in the filters. (3) Impossible a new plan. Analysis of real Chromate average.
Mistakes lost. Phenolphthalein.

For 9,75 lbs Cac are 3,6 lbs Tailings
i.e. for 1 lbs Bism are 2½ lbs and ore = 2½ necessary and ½ lbs = 14 Carbonate Soda dry and 14 Chlorhydric H_2SO_4

3/9 Chemical Earth sieved coarse 455 g + 10 cc H_2SO_4 [illegible] and heated in porcelain crucible over [illegible]

for ½ hour. Residue 323 g red colour [illegible] mass light. Added 246 g 66% H_2SO_4 C.P.

Dis 2535 } Bichromate 778 g Solid
" + Bichr 1313 } 742
Chloride } 742
Bricks 1277 } 1259 } 54

Taken 273 g (= 223 g [illegible] (page 86)) of this tail. Dissolved

Bichrom. + 78 g H_2SO_4 poured in and boiled once

more = half plate 55 g con. Lose + 3.4 g = 5.5 g

300 Liter + 190 H_2SO_4 con. lose 55 g = 14 g

986 − 771 = 1269 − 283 = 986 therefore loss of Bichromate 771 − 771 = 2 g instead of 12 g as $Cr_2O_7Na_2 + 2H_2O$ would lose.

[illegible] 223 [illegible] 10 cc 66% H_2SO_4 Commercial (1.84)

for 1 Bichromate 800 g H_2SO_4 instead of 801

3/12 120 g raw Chemical Earth sieved coarsely

30 g H_2SO_4 Commercial 1,848 spec

only a little SO_2, not much heated by mixing

continued page 101

Kaolin: Gypsum, anhydrous, hydrated, floated talc

absorb almost their own weight of H_2SO_4 while raw

Chemical Earth sieved absorbs 5 : 2, heated to 200° (300° long) absorbs 4 : 1 (good to heat it after weighing to [illegible])

For Copper determination 10 g $CuSO_4 + 5H_2O$ Sol

spec 1,065 10 cc = 10,65 g + the dilution to 106,5 g

in 1 cc 100 g Cu liquid — 10,5 10 g Sol. − 1,05 Cu with = 105.252 = 265 g

dilution will then amount to 265 cc 1 cc Cu in 1 cc

Dissolved (1889 1) 5 g 26,5 3,9 g Cu Bichromate Tailings No 1

(Raw 2) 12,5 − 19,5 = 2,35 Cu in 1 g [illegible] " Cone "

08 3) 12,5 − 6,8 = 5,7 g " 6 g Bichromate supernatant Cone No 2

34 4) same as solid 29,5 − 29,5 g Cu 3,0 g " Tailings "

12 g 8) " 144 144 g Experimental Bichromate No 2

9 g 9) " 150 g = 16,0 g Cu " " " 1

9 g 10) " 89 g = 9,9 g Cu " " 3

For Nickel determination was Fe as $Fe_2(OH)_6$ precipitated by Ammonia and then 1 g ammonia Nickel solution and Sodium Sulphide solution added found weighs 1,3 three − 1,8 134 − 12 9 9 g Ni.

Dissolved Bichromate mash 8.

The Earth Solutions for 500 g are amounted to weighs

for Nickel 1-4 each 50 cc for Nickel 8 & 10 112 112 152 cc

Organic 9 spec for Cu Ni Analysis 3 samples

for Mr. Dickson. Each taken 2 g floated Dis-

solved in dilute Nitric acid, precipitated by H_2S

filtrate 3 times precipitated by Ammonia and so all organic gone

Solution alone weighs for Nickel 25 1100 1100 1100 g

Ni determined by colorimetric with Sodium Ammonia

weighs 1,8 1,8 2,5 g Ni. Cu in colorimetric [illegible]

2,8 0,3 8,4 g Cu

Barkeiers (see pag 90)

2/12 300–400 Kollerei charges (same) ordered today
for each 300# fill 66° H_2SO_4 and 200# Infusorial
Earth. The kettle is heated to c 200°C & Lean
Alen mixed with the Acid and heated once more
as high as that for c 15–20 min in the air oven.
to be ordered 200 lbs Infusorial Earth
4 charges full strength H_2SO_4 for refiners
Geiler. Kettle empty 1399#

2/13 1 pail coarse Chromate ore contains (see pag 89)
19 % Cr (≡ 36,3 % CrO_3 ≡ 56 % Bichr. Soda equiv)
or 49,7 % Cr_2O_3. FeO
it was heated with ¼ pail CrO_3 freed & dried in
the furnace with Bunsen blast for c 6 hours
yellow heat for 3 hours. Mass was quite dark
while at the beginning white with only many
black particles. By H_2SO_4 or Sod. Solution the
CrO_3 was extracted. The overall mass was
entirely porous. The ore if ignited and not put
out but in cold water can be handpicked easily be pulverized. Coat the ore with Lime water and dry quick
on with NaOH into or mix it with Magnesium chloride
or Magnesium chloride (= $MgCl_2 + O$). Dry Barry &
Water Ford at the top of Decomposing Bath (c 650°C)

3/20 Chrome ore with Carb. Soda & CO_2 Ca precip. gave little result than with $BaOH_2$ aq instead of Soda. (76:62) but only here only 14% Bi-chromate (for 100 ore) instead of 56% by one treatment.
MnO_2 in small quantity may increase the oxidising or CO_2 in small quantity.

N.B. What is the usual price of Chrom. Ore one and Chrom. Lead one? (Cr in 44% or 30 to 40 per ton)

Fused 50g Chrome ore (sieve 80) + 3g Lampblack heated in Pt crucible.

N.B. Chromate + Thiosulphate Soda or H_2SO_4 heated to the result g mass after powdering $CaCl_2$ added and heated again.

Take 217g Ore (sieve 80) + 65g Cryolite well ground together and fused in 3 alternate layers with 80g Mixture of 64# H_2SO_4 + 16 Infusorial earth and heated in lead crucible.

Test. Infusorial earth + H_2SO_4 (2:5) 03 simply mixed stood 10 days
Then 30g 40 grs Bichr Soda (Bikarda) Sol + 33g conc H_2SO_4 + 62g aq = 125g Sum a
and 30g Bichr Sol + 46g Infusorial Acid + 62g aq 138g Sum
separate heated to 150°F = 64°C
5 ½ hour and both titrated 100:108
therefore 74% has by now leached the Earth.
On mixing 30g 40 grs Bichr Sol + 33g conc H_2SO_4 and cooling apparently nearly all Chromic Acid separated out, the mother liquor being only slightly colored. Cheap way to prepare Chromic Acid, by the mother liquor from a cooling can be freed from H_2SO_4 by crystallizing and the used again.

If the proportions of Bichrom H_2SO_4 aq are lbs: 16, 5 lbs: 4 Chrom Infusorial Earth heated 4, 1 reports leached 6.6 lbs will be there with no leached Earth a loss ~~of from the Earth~~ of 0.5 lbs = 4,5 + Bichr and and excess of Earth necessary of 2,5 lbs = 2,5 + Sum 7 + for in excess of the necessary 4, 1 lbs = 4,1 therefore heating is indispensable.

3/21 The above showed to Mr E. Baldenweck with regard, the best ale

cadmium 9 may 1897

Proposed $PbMnO_4$ and ask received to prepare it.

Literature Wagner '87 Regenerate by dark red heat, nal digester.

$KMnO_4$ boiled $= K_2MnO_4 + \frac{1}{2}O$

or in clay crucible or iron (see Zeyfferset)

5 g KOH 3,5 PbO_2 (or nitr. NO_3K) powdered + 4 g fine MnO_2 + 10 cc aq quick dried over lime. Lumps and some unattacked lead formed insol. soluble in aq.

Let cool a bit and keep on add water (not too much).

$KMnO_4$ + KOH + Alcohol give K_2MnO_4 even cold.

Used 2,63 g/cc $KMnO_4$ Solution containing 0,164 mol/l and an Acet Lead Sol. containing 1,39 Normal KOH 4,3 Norm.

a) Mixture 65,3 cc Mn + 25 cc K hydrid + 77 cc Pb + 10 cc HNO_3 (2N) + 8 cc Alcohol boiled.

b) 1 l Mn + 25 cc 7N HNO_3 + 110 cc Pb + 30 cc/ov Alcohol cast filtered colorless and diluted to c. 2 liter.

c) Some 1 l Mn + much KOH (10 Norm 1,3 N NaOH) + a little Alcohol (green a quick clear) + $Pb(Ac)_2$ and then much Acetic Acid added to redissolve $Pb(OH)_2$.

Question: is $PbMnO_4$ insol in conc NaOH?
can it be formed by heating Pb_3O_4 and MnO_2?
can Empirical $Pb(OH)_2$ flakes be transformed in alkaline manganate Alcoh. solution?
Can $Pb(OH)_2$ flakes transformed by Permanganate be reduced to Manganate by Alcohol?

$PbMnO_4$ = 325 will loose only 16 = 5% Oxygen.
Bichrom Sode required 50, this 160
Since about 10 % pb lb, can be regenerated.

d) 1 l = 164 mol. Among conc. oxydic 4 % Alcohol to Aldehyde or 2 % to Acetic Acid if used in alcoholic solution = 120 cc Pb Acet

Try flask Litharge + Manganate Alcohol and crystalline Litharge too.

$Pb(OH)_2$ conserved to a plate and then treated in Manganate solution + caustic soda.

or in conc Sol of pure Manganate Soda produced from the air dry KMnO4 or gasoline gas or etc.

Manufacturing Bichromate

for 200 lbs Bichr Soda

There are tak 600 lbs ore containing 22% chromogen part of 13% Chrom, to be mixed the chrom part with 90 lbs Cryolite and 100 lbs Ac Sulph and heated then added 200 lbs of Caustic Lime and roasted.

Then treated with Soda Solution and the Solution evaporated,

The ore was heated in the last experiment at store only floated ore was used at first to 400°C

for one 100 g floated ore } 3 hours
Lasted 50% Cryolite, 13% Ac Sulph } 200 - 400°C
separate larger ... the same vessel, to heated for 3 hours

then mixed with 50 g Caustic Lime and roasted at moderate-lively redness 3 hours, boiled with conc Solution of 14 g Soda, settled, decanted & evaporated to crystallization Result 32 g Bichromate Soda

Prot Bichromate Manufacture

1,2 tons chromogen per ton 3 tons ore

200 lbs Cryolite $25.00 $54
400 700 Ac Sulphuric $
600 " Chromogen $ 5,00
800 Soda $ 18,00
1½ ton Lime $ 9,00

2000 lbs $ 86
1 lb 4,3 ¢ price 9¢

If 44% Chrom ore Ton $40 is used
only 13/44 = 3,4 = 1760 lbs = $ 35,20 is needed
+ 600 lbs Chrom ore = 3,00 + 800 Soda = 18,00 + 2000 Lime = 5,00 lbs
Sum $ 61,20 = 3,1 ¢

The above figures delivered 3/29 and Experimental Plant Estimate and Drawings promised to deliver next week.

4/1 The 44% Cr ore can be purchased for $5 per ton in ship to Niagara Falls on rail. Centrifugal rollers to $150 size for $12 per ton. It is to be roasted in oven ($1 per ton) or if 10 tons $2 per ton if 5 tons in 29 tons per day. Cooled in revolving axes ($40 lining) and then to be leached in revolving furnace are mixed with 2-3% Na_2CO_3. Price of 95% to 98% Na_2CO_3 2¼-2½¢

Sodium bichromate 55% 13 6¢ | Soda 1¼¢ (Pure 95%) bulk
Potassium chromate 60% 18 | bulk ore 50% Cr contains 97% Na_2CO_3 for 1.05¢
Chromic acid 65 1¢

Chromate bulk than bulk of soda. Simpler furnace be used. The roasting is to be done at still red heat but not blazing red heat. The chromic acid can be prepared indirectly by Sulphuric acid and be centrifuged and washed on. CrO_3 can be decomposed by SO_2 or H_2SO_3 etc. or chromic acid can be decomposed by the Sulphuric. CrO_3 is also used for reducing CO_2 down to ~~[illegible]~~ coal is with CrO_3.

The Monochromate is transformed into Bichromate by CrO_3 prepared from one Monochrom Sal by H_2SO_4 centrifuged.

Chromate Bichloride from pag 103 109

3/30 6: 16,5 : 40
20,6 lead Dissolved on 27,2 not lead done
$11\frac{1}{2}$ = 15% 90% Brich Sal
% 21 cc aq
both Samples heated 9-11½ 152°F 11½-1½ 124°F.

9/6 Since a 2½¢ tested and found
Coarse Fe As Sb no Lead but in Sumna less than 1/100 % 2.99 dissolved, less than 20 mg in Sumna.

Filaments cable for pass

3/12 Sample
Cable Tell evaporated to 95% + pour + add 2675°
other Leading 3 hours 262,3°
cable be drawn into filaments at 150°C
is not enough elastic for the lamp filed at 200°C.
Thing more Leaded 256 + 15 = 271,5° nail can
scratch the melten mass, bon milling point
The mass drawn into filaments and heated carbonizes very nicely, quite strong, not much brittle
then heated gradually and to a very high temperature. Not to be calcined with the light carbonel material.

C. Iron

Wanted a 3/29: Molybdenite of Fine equal parts
fusible before the Blowpipe, fine grained.

1) Ammonia Sulphate: Chem News 20 191
$FeSO_4 + Na_2SO_4$ calcined and washed in Pt Crucible
in H_2 stream followed by acid Permanganate, alcohol Ether & conc H_2SO_4)
at 350°C reduced, then heated in air and the spongy Cu-
pressed to ½ vol and L Calcined with Oxygen free
metal.
Methods of Fe ($FeSO_4$ + $MgSO_4$ + $MgCl_2$) contains to much
gas (p, CO_2 etc)
Fe reduced must be spongy & entirely soluble in Dilute Acids,
2) Wöhler: CO_{all} 1263 Cover Fe fused in Zn.
3) Schlechtendal Jahrb 55 255 Alloys of Fe heated below
melting p. of Zn in Hydrogen. Soluble Fe alloys much
than ordinary temp: the Carbonyl to redness gives Nitride
$9FeCl_2 + 4NH_3 = N_2Fe_4 + 8HCl + 2H_2 + N_2$
The Fe_2Cl_6 sublimed saturated with NH_3 etc

36 N.B. 6 No 36-47 Ulmic Acid
prepared made from Cane Sugar, Maple Syrup.

36 Ulmic Acid

37 Metapellic Acid Crude heated to about 400°F.

38 Ammonia Salt of Ulmic Acid

39 Same as 38 but heated longer.

40 Carbon from Metapellic Acid

41. Carbon and Metapellic Acid Crude

42 Phenyl Biborate

43 Ulmic Acid nearly exhausted by NH_3 and H_2O and made according to receipt on page 3 Ulmic Acid I.

44 Made the same as 43 but heated for 3 or 4 days on steam bath

45 Ulmic Acid made at a low temperature?

46 Ulmic Acid made according to II page 3 ~~last portion~~

47 Made as 39 but another lot. Metapellic Acid and NH_3.

48 Biborate of Beta Naphthol. 123

49 } 50 } Samples of Metapellic Acid & NH_3

51 Metapellic Acid dried on mercury and on glass. 51a the same heated more

52 Catechin dissolved in H_2O with or without NH_3 Ulmate of Ammonia.

53 Catechin dissolved in H_2O but heated more than 52

54 Samples of Ulmic Acid made from Maple Syrup.

55. Ulmic Acid made from Caramel and evaporated partly with NH_3

56 Ulmic Acid most soluble in NH_3 made from Recipe No 1 page 3

57 } Tannic Acid 20
Potassium Sulfate 40

58 Al. palmitate neutral or a little basic

59 Ditto + S_2C.

Month 89 to April 1.'89 } **Ore Extraction** { Nickel and Copper.

Principle

1) Matte + S + H_2Cl_2 matte and in molten state passed by before a magnet and the fluid part so separated. at a temperature over 400°C, the next time dito with above melting point at 150° so that it is magnetic.

2) Ore or Matte pulverized and roasted to be magnetic and at 400°–500°C separated by the magnet. The Non part cold separated again in Ni-Copper oxyd and Silica and the magnetic part of the last separation broke up by $H_2Cl_2 + H_2SO_4$ and separated cold ace mine in NiSO and CuO or NiS and CuS after treating with Sulphur instead of H_2Cl_2.

Done

3) Wet way. The Matte concentrated by roasting with Silica pulverized very fine and mixed with finely pulverized $Fe_2(NO_3)_6$ intimately and heated to 120–200°C for 3 hours and boiled with water and dil H_2SO_4.

Done good indications.

4) Speiss forming: The concentrated Matte + Arsenic Bisulphide melted together removing S as completely as possible and then roasted with Silica to remove most Iron. The Speiss and Slag then contains all Fe nearly as arsenide.

N.B. $FeAs + FeS$ melted $= 2FeS + As$

All Fe as S is below, nearly all Fe and all As is above with As.

Notebook, N-88-03-20.1

This notebook covers the period May-October 1888. All entries are by Charles Batchelor. The first 25 pages contain notes regarding applicants for jobs at the laboratory. Included also are 10 pages of notes and drawings relating to the talking doll and 2 pages of armature drawings and calculations. The front cover is labeled "Help - Applications Addresses (Batchelor, Charles)." The book contains 112 numbered pages.

Blank pages not filmed: 40-109, 112.

N-88-03-20.1

1

Moriss Heizer May 1888
(34 yrs.)
84 Fery St. Newark
glasblower Glassblower
good for machine in New shops.

2

Toolmaker. May 1888
Mac C. Bond
232 Walnut Street
Jewelers tools & light mach.
(passable (not very bright)
about 28 years.

3

Experimente May 1888
E. T. Neuse.
1256 Dean Street
Brooklyn, N.Y.
Int. by E. Weston
not very smart looking

(2)

4

Machinist — Gustav Hoffenberg.
39 9th St
Hoboken N.J.
Firm Delineator
Looks like a good man for contract

5

Workman — May 1888
Jos. L. Petsch
Clarkson St.
Flatbush L.I.
Can do a little latte work. looks like a good man

6

Wei Hand — Mch 20. 1888.
A. M. Sharpe
41 French St
New Brunswick N.J.
Good man for Contract.

(4)

May 1888

Armature Men

7 Fred Flammer
18 Barbara Street
Newark. N.J.

Good.

Laborer

8 Thos Swan
84 Stone Street
Orange. N.J.

Good for Contract work.

No trade

May 1888.

9 Eugene B. Feller
220 High Street
Orange N.J.

Married - Steady
about 25

Worked a great deal in acids -
Would be good for contract
looks bright & anxious to
get work

(6)

10

Its trade. Clifford Waters
Age 18 or 19 355 Jay Street
Brooklyn

Been at Bookbinding
Recommend from Smith - Mat. Rev. Makes.
Good to run some machinery
May 14 1918

11

May 1918.

Is Run Machinery J. H. Nolan.
Looks steady 174 Bleeker Street
about 35 Newark, N.J.
Well used to running
light machinery

12

Buffer & polisher Nicolas Lynch
about 28 102 Sheffield St
looks like a steady Newark N.J.
man

(8)

13

May 16 1888

Machinist & Electrical Man
About 25
Worked at Gouck St
in N.Y. Meter

W M Keen
8 Centre Market place
New York

14

May 16 1888

Graphophone Contractor at present

Has Contract in Graphophone at present

G. M. Gonyard.
6 St Felix St
Brooklyn N.Y.

15

Sewing Mach Man.

Worked at Sew. Mach Co

W J. Halsey
406 Halsey St
Newark, N.J.

(10)

16	Sewing Machines Dom Sew Mach Co	Wm Cunningham 211 Plane Street Newark N J
17.	Machine Man. Good Worker good.	J. W. Jones Washington St (45 years old)
18	Engineer about 30 years.	John Waer 97 Acton Street Newark N J.
19	Boy 18 years. Has worked at Butchering	Septimus Wisner 105 N. Park St. Orange N J.
20	Boy 17 years Has worked at Glazing	Fred Bower 105 N Park St Orange. N J.

(12)

21	Has been Coachman but looks like a smart fellow to take contract — About 28	Fred. Wessart 89 Watching Ave Orange N J
22	Supt. of Nottingham Tech School.	~~J Ryan~~ C W Hilton Mrs Riker Day St.
23	Machinist	Otto Mulcay 564 Hudson Street N Y.
24	Good to take Contract	David Hopper Care Geo Halford Orange N J.
25	Blacksmith & fellow {About 50 but active}	Joseph Plummer care Ben Mortimer Bloomfield Ave Bloomfield

(14)

26	Needs work in Storeroom Not much good	Wm J Cregan 21 Mulford St East Orange N.J.
27	Age 21 Gen. with W Electric Newark N.J. Putting up safety chips & Screwing clamps & hinges on boxes	Wm McGovern 22. N. Parker St.
28	Bench work at U.S.C. About 25	Wm Donahue 81 Sussex Ave Newark N.J.
29	Hasbeen & lamp packer	John Hunter 11 Searing Ave East Newark N.J.

(16)

30

Ex trade
Chas A Hopkins
24 Elizabeth Street
Orange N J
About 23
Worked last at
Boonton paper mills

31

Has been
running machine
& Cut lawn
& Screw machine
or lathe

Wm. Beans.
Age 19.
64 William Street
Orange N.J.

32

Polisher &
Buffer
on nickel plating
or
Japan work.

Michael Lannon
age 23
25 Cone Street
Orange, N.J.

33	about 38 Bench worker & locksmith	Fred. Schechterle 12 Rankin Street Newark. N.J.
34	about 19. Screw mach. & power press at U.S. C.L.C.	A. W. Pierman 14 W. Monroe St. Newark. N.J.
35	Machinist	J. B. Creed 8th Ward Hotel Newark. N.J.
36	Ripeman	W. H. Goodman 147 High Street Newark N.J.

(20)

37	age about 20 Hatting & Printing machy	June 3 1888 M. H. Kiefer 43 White Street Orange N J.
38	Man about 35 Klein machine	F. Bock. 76 Camden St Newark N J.
39	U.S.Co. Sewing mach. & press. About 18.	C. Rogers 7 Reservoir Place Newark N J
40	24 Mathematical Inst.	Franz Schmidt 3 First St Hoboken N J

(22)

41

41 Jerome Knight
Age 27.
Blacksmith: 179 N. Park St
Tool maker
@ Orange

42 W. R. McDonald
Toolmaker 61 State Street
good man I think Room 3
but wants $3.75 Boston Mass

43 Adam Tale Jerr William Berry
good 61 State Street
Cutter Room 3
Boston

44 Adam Leimer
Age 22
Worked in hat 215 Main St
Store
Orange N.J.

(24)

45 Peter McGovern
20 age
36 Parker St
Newark.

Has put up Drill presses — soldered + done lathe work at U S C.

46 J. W. Phillips
25 Acthen Street
Newark N J

47 William Rowan
23
10 Beach Street
New York

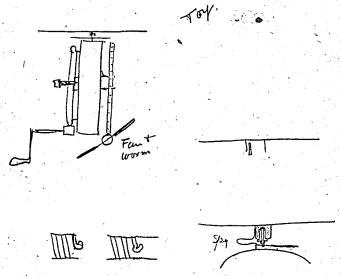
~~Machinist~~
good man as Driller —
Contract

(26)

48 W.

28

Oct 19th 1888.

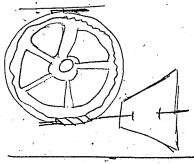


Try talking on the top of groove —
Cut deep groove + then polish
off top + talk with a wide knife
then recurve also with wide needle

CS

Loy Oct 19 1884

How English get cheapest clock movement made — Spring one wheel, + worm, + fan —



Make small diaphragm with flapper needle — diaphragm same size as ordinary phone.

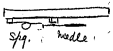
(27)

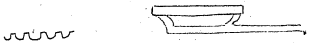
Oct 19 1888

CS

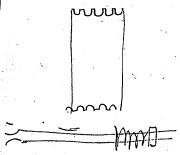
(34)

Oct 19 1888



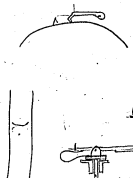


Make top '008" + cut tallying on that – then buff off the edge to use for guide – using swivel flapper

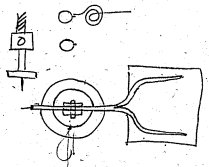


(58)

Joy Stoll. Oct 23 1886



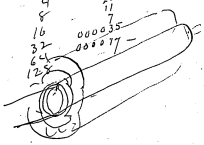
Spring for Reprod. needle fastened & Collar that turns in accord to put on friction on needle.

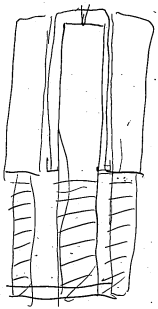


(110)

1. — 0030
2 0015
4 00075
8 00037.

1 ~~1000~~ 120
2 0009
4 00075
8 23
11
16 7
32 000035
64 000037
128





Notebook, N-88-03-23

This notebook has one dated entry, written by H. De Coursey Hamilton on March 23, 1888, regarding experiments on diaphragms for the phonograph reproducer. At the end of the book are 6 pages of drawings relating to the phonograph. The front cover is labeled "Phonograph." The spine is labeled "59." The pages are unnumbered, and the book has been used in both directions. Only 8 pages have been used.

Phonograph. Mch. 23"-88.

Geo. B. Hamilton.

Experiments on diaphragm of the [illegible] producer preparing it so that it will [illegible] exclude moisture.

#1. After washing sticky stuff off & drying it I soaked the gold-beaters skin in Boiled linseed oil & hung it up to oxidize

#2 - Washed gold-beaters skin soaked in Rubber dissolved in Benzol & hung up to dry.

#3 - Washed gold-beaters skin soaked in Gutta percha dissolved in Benzol.

#4. - Soaked in thin shellac

#5. - Soaked in Collodion.

#6. - Soaked in Copal Varnish

#7.— Washed gold-beaters skin soaked in Raw Linseed oil.

#8.— Soaked in Paraffine oil

#9.— Soaked in Paraffine dissolved in Benzol.

#10.— Soaked in Gutta-percha dissolved in Chloroform.

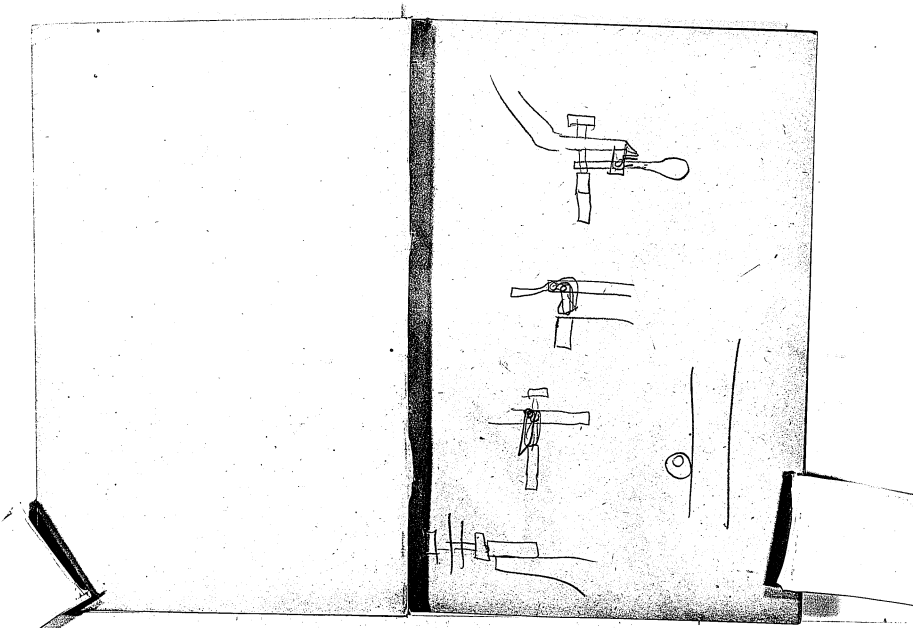
#11.— Unwashed gold-beaters skin soaked in Benzol.

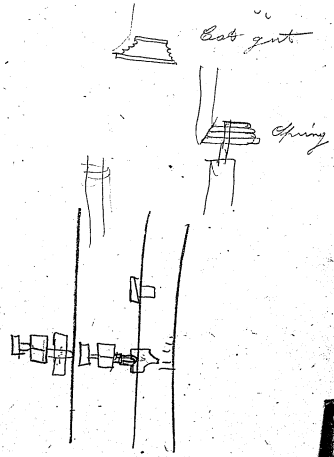
#12.— Bolting cloth soaked in Boiled Linseed oil + allowed to oxidize.

#13.— Bolting cloth soaked in dissolved Rubber + Gutta percha.

#14.— Gold beaters skin sipped in melted paraffine + scraped off.

[THIS BOOK WAS USED IN BOTH DIRECTIONS. THE FOLLOWING PAGES WERE FILMED FROM THE BACK END FORWARD.]




Cast gut
Spring

Notebook, N-88-03-30

This notebook, which covers the period March-July 1888, is a continuation of N-88-02-17. The book contains notes by James W. Gladstone regarding tests of chemical compounds for phonograph cylinders, tobacco bleaching, and battery solutions. Inserted into the book are 2 pages, one of which is a list by Edison of solutions. The spine is labeled "62." The pages are unnumbered. Approximately 130 pages have been used.

XE-172 N-88-03-30

March 30th 1888

— Phonograph Cylinders —

Pan No 5 contains
100 White Glue.
25 Glycerine ✓ 100 soft NG

Pan No. 1 100 White Glue.
25 Glycerine - 100 soft NG

Pan No 4 100 White Glue.
25 Gum Arabic 100 soft NG

Pan No 2 100 White Glue
20 Glucose - 100 soft NG

March 31st 1888

Pan No 3 100 Gum Arabic
20 Glycerine 100 soft NG

Pan No 10 100 Gum Dextrine
20 Glycerine 100 soft NG

Pan 8 100 Gum Dextrine
10 Sweet Extract 100 soft NG

Pan No 11
100 parts Gum Dextrine
20 Egg Albumen
wont mix

Pan No 7 100 Gum Dextrine
10 Gum Arabic
too soft NG

Pan No 6 100 Dextrine
10 Carbolic Acid
too soft NG

Pan No 12 100 Glue
20 Chloride Zinc
too soft NG

Pan No 13 100 Glue
100 Gum Tragacanth
too soft NG

Pan 8 100 Glue
100 Gum Apleys Resin
too soft NG

Pan 6 100 Glue
100 Gum Ammoniac too soft NG

100 Glue
100 Potatoe Starch.
too soft NG

100 Glue
20 Egg Albumen
Wont mix.

100 Gypsum
50 Paraffine
50 Mineral Rees Wax. wont do
~~50 Carnauba~~ too

100 Gypsum wont do
50 Paraffin
50 Mineral Rees Wax.
50 Carnauba Wax.

Monday 2 April 1888.
100 Glue
50 Glycerine
50 Flour wont solidify NG

100 Glue
100 Resin
25 Castor oil wont solidify NG

100 Glue
20 Glycerine
50 Flour
wont solidify NG

100 Glue
20 Glycerine
50 Carbonate Potash
100 Resin
35 Castor Oil
wont solidify NG

100 Glue
100 Logwood
too soft NG

100 Glue
100 Gum Dammar
wont mix

100 Glue
100 Gum Mastic
too soft NG

100 Glue
100 Gum Tacamahac
wont mix

100 Glue
100 Gum Senegal
too soft NG

100 Glue
50 Boric Acid
too soft NG

100 Glue
50 Camphor
wont mix

100 Glue
50 Gum Thus
too soft NG

100 Glue
200 Sulph Alum
too soft NG

100 Glue
400 Sulph Soda
too soft NG

100 Gum Dragon
400 Stearine
wont mix

Tuesday 3 April 1888

100 Gum Arabic solution Saturated
50 Litharge
Wont solidify.

100 Gum Arabic
50 Litharge
25 Borax
solidifies into lumpy mass NG

100 Gum Arabic Sat Sol NG
50 Borax
solidifies into lumpy mass

100 Glue
100 borax
forms very stalagmitic mass of Glue NG

100 Gum Arabic
50 Violet Aniline too soft NG

100 Gum Arabic
50 Ammonia Citrate Iron
wont harden NG

100 Gum Arabic
50 Ammonio Citrate Iron
Flour
wont rise NG

100 Gum Arabic
50 Nitrate
wont harden. NG

100 Gum arabic
25 Cyanide Potassium
wont solidify NG

100 Gum Arabic
5 Lactic Acid
wont solidify NG

100 Gum Arabic
15 Glacial Phosphoric Acid
too soft NG

100 Gum Arabic
20 Boracic Acid.
too soft NG
does not mix properly

Gum Arabic 100
Irish Moss 50
Sto
Wont Harden NG

Glue 100
Bichromate Potash Solution 100
Wont solidify NG

Wednesday 4 April 1888

Stearine 100
Olive Oil 50
Palm Oil 50
Sal Sol Soda 20
Salt 10

too soft

Olive Oil 100
Sal Sol Soda 20
Resin 20
Salt 10

no bind –

Olive Oil 100
Sal Soda 20
Salt 10

NG

Olive Oil 100
Litharge 50
Water 100

wont solidify –

Carb Soda 100
Borax 50 to red heat.

too hard + stony –

Thursday 5 April 1888.
Evaporated Gelatin dissolved in water & acetic acid.
100 water
10 acid

Gelatin Solution with water treated with Sulphuric Acid –

Gelatin Solution with water
treated with Tannic Acid &
then evaporated

Gelatin Solution with water treated
with Tannic acid & then 25% fine melted
sugar added to the solution

75 Gelatin Sat Sol -
25 Glacial Acetic Acid -

Gelatin + Picric Acid

Gelatin + Bichromate Potash
spongy Elastic mass -

Gelatin + Chromic Acid
(wrinkle up -

Gelatin + Molasses

Gelatin + Citric Acid -

Gelatin + Sulphide Arsenic
when hot not sticky -

Gelatin + Sulphur

Gelatin + Carbonate Lead

Gelatin + Molybdic Acid

Gelatin + Gallic Acid
Tends to stop scum from rising to surface

Gelatin + Sulphate Manganese
very stringy & stiff

Gelatin + Cobalt Blue

Gelatin + Chlorate Potash

Gelatin + Nitrate Potash

Gelatin + Sulphuret Antimony

Friday 6 April 1888

Gelatin + Sulphate Ammonia
Elastic Tough Stringy best

Gelatin + Sulphate Alum N G

Gelatin + Sulphate Baryta N G

Gelatin + Sulphate Strontia N G

Gelatin + Sulphate Magnesia
Elastic Tough Stringy

Gelatin + Sulphate Potash
Elastic Tough Stringy

Gelatin + Sulphate Soda
Elastic Tough Stringy

Gelatin + Oxalate Soda N G

Glue + Permanganate Potash

Glue + Sulphate Soda
Stringy + Sticky

Glue + Sulphate Ammonia
Elastic Tough Stringy
Equal parts

Glue + Sulphate Magnesia
Stringy + Viscous

Glue + Sulphate Magnesia
+ Bichromate Potash
Stringy + Viscous

Saturday 7 April 1888

Gelatin + Blood Albumen

Gelatin + Blood Albumen + Bichrom Potash

Gum Arabic + Sulphate Potash

Gelatin + Egg Albumen

Gum Arabic + Plumbago

Gelatin - Palm Oil, Sulph Ammonia, Alcohol

Gelatin + Carbonate Magnesia

Gelatin + Boracic Acid

Gelatin + Boracic Acid + Bichr Potash

Gelatin + Ammonio Citrate Iron
Sticky, Jelly with substance

Gelatin + Sulphate Iron
Stringy + Elastic, Sticky

Gelatin + Residue after distilling Liquor N

Gelatin + Microcosmic Salt
Phosphate Soda + Ammonia
Stringy + Elastic

Gelatin + Natrium Nitrame
not sticky
Only Stringy + Elastic

Gelatin + Stannate Soda

Gelatin + Sulphuret Potassium

Gelatin (Pure Bassorin + Caustic Potash) NG

Gelatin + Sulphate Copper

Gelatin + Oxide Antimony

Gelatin + Hyposulphite Soda
not sticky
Only stringy + Elastic

Gelatin + Phosphate Soda
Stringy + Elastic

Monday 9th April 1888
Gelatin + Ammonia forms a Jelly
not sticky

Gelatin + Ammonia + Sulphate Ammonia
+ Glycerine
NG

Glucose + Ammonia + Tannic Acid

Gelatin, Ammonia + Bichromate Potash.

Gelatin + Calcic Nitrate
NG

Gelatin Calcif Nitrate Ammonia

Glue - Glucose Ammonia Tannic Acid

Gelatin - Ammonia Gum Arabic -

Gelatin + Dry Sym. Decbure

Gelatin + Oxide Bismuth

Glue + Gelatin + Oxide Bismuth

Glue + Carbolic Acid Thus it

Glue + Carbolic Acid + Glycerine

Glue + Canauba Wax + Carbolic Acid

A

1 { Palmitinic Acid 15 gms.
Caustic Soda 2½ —
Water 40 cubic centimetre

2 { Chloride Alumina 4 gms.
Water 20 cubic centimetres.

Heated gradually when cold too soft.

B

1 { Palmitinic Acid 15 gm.
Caustic Soda 6 grs
Water 40 cubic centimetre -

2 { Chloride Alumina 4 gr.
Water 20 cubic centimetre

1 + 2 mixed gradually when cold.

C.

1 { Rosin 22½ gm.
Caustic Soda 8 gm.
Water 40 cubic centimetre

2 { Chloride Alumina 4 gr
Water 20 cubic centimetre

1 + 2 mixed gradually + carefully washed afterwards 4 or 5 times

D

Canauba Wax 70 %
B mixture 30 %

A. B. C + D experiments were made in Dr Millington's room under his guidance -

Tuesday 10 April 1888

Cleaning & putting away apparatus used for organic work - - -

~~Not Lactic Acid~~

~~Today~~ 11 April 1888

Wednesday

Not Lactic Acid -
2 Commercial Alcohol.
3 Acetic Acid pur.
4 4 drops Nitric acid ⅋ in water
5 ⅋ drops Sulphuric Acid in water
6 ⅋ drops Hydrochloric Acid in water
7 { 3 drops Sulphuric Acid
{ 3 — Nitric Acid } in water
8 { 7 drops Sulphuric
{ 4 — Hydrochloric Acid
9 { 4 drops Nitric
{ 3 — Hydrochloric
10 { Equal parts Sat Sol Lewis Liq & Water
11 Silicate Soda Liquid
12 10 drops Carbolic Acid & Water -
13 10 drops ——— in Ether -
14 Liquor Ammonia 26% -

Lights
NCt

15. Boric Acid & Water - 500 mg & water
16. Ammonia Citrate Iron & Water (100 mg + aq)
17 Molybdic Acid & Ammonia (100 mg + Am)
18 1 gram green vitriol & Water
19 Chlorine water
20 Ether Nitrous ver 15%
21 Ether ozonic
22 Alcohol propylic 1/2
23 Urobin 1/2
24 Acetone 1/2
25 Benzole 90%
26 Toluene
27 Naptha
28 Alcohol Butylic (iso)
29 Oil of Myrbane.
30 ~~Rho~~ Rhigolene -
31 Chloroform
32 Aldehyd
33 Alcohol Amylic -
34 Ligroin -
35 Acetate Amyl
36 Amylozyhydrat
37 Chloral hydrate 1/2
38 Isobutic alcohol
39 Paraldehyd Alcohol

40 Nitrite Amyl
46 Butyric Acid concentrated 1/2
41 Chloric Acid 1/2
42 Formic Acid 1/2
~~43 Hydrofluor acid Acid 1/4~~
43 Perchloric Acid pure 1/2
44 Acid phosphoric 1/2
45 ~~Chloric Acid~~ Sulphovinicum Acid 1/2
47 Pyroligneous Acid
48 Bromine 1/4
49 Ammonium Chloride Sol.
50 Hydrosulphuret Ammonia 1/2
51 Nitrite Ammonia 1/2
52 Amol 1/2
53 Sat Sol Chloride Manganese 1/2
54 Chloride Sulphur 1/2
55 Calcium Bisulphurosa 1/2
56 Silicate Potash
57 Nitrate Iron Sol
58 Sulphide Ammonia 1/2 CR
59 Bichromate Potash Sol.
60 Chloride Barium 10% tag
61 Tannic Acid Water

62 Gasoline
63 Nitrate Hydrogen
64 Sesqui Chloride Iron Sol
65 Methyl Alcohol
66 Bromic Acid
67 Hydrate Bismuth
68 Nitrate Cobalt
69 Sol Nitrite Potash
70 Hydro Sulphuric Acid
71 Calcium Nitrate
72 Gallic Acid
73 Sol Tann Ac + Hydrochloric Acid
74 Bisulphide Carbon
75 Chloroform
76 Hyposulphite Soda 1pt water
77 Microcosmic Salt 1pt water
78 Chloride Barium 500mg water
79 Chloride Calcium 500 mg
80 Boracate Soda 500 mg
81 Sulphate Ammonia 500 mg
82 Carbolic Acid Alum
83 Arsenious Acid Barium
84 Ferrocyanide Potash 50mg + water
85 Bicarbonate Potash 100mg water
86 Sulphate Alum
87 Sulphate Potash
88 Bicarbonate Soda

101 5 gram Chloric Acid 8 oz water —
102 Bromine Gas —
103 20 drops Bromic Acid
104 { 30 " Nitric Acid } added to distilled water 8 oz
{ 30 " Hydrochloric } 8 oz distilled water —
105 { 30 Sulphuric } in water
{ 30 Nitric }
106 60 drops Nitric Acid in water

89 Natrium Wolframic 100 mg to water
90 Sulphate Soda —
91 Bicarbonate Potash —
92 Nitrate Potash —
93 Nitrate Soda —
94 Bichromate ~~Iron~~ Chromate Strontia —
95 Sulphate Magnesia —
96 Bicarbonate Lithium —
97 Arsenic Acid —
98 Red Prussiate Iron —
99 Stannate Soda —
100 Oxalate Ammonia —

Friday,

107 Chloride Lime Solution —
108 Hypochlorite ~~Lime~~ Alum —
109 — Zinc —
110 — Potash —
111 — Iron —
112 — Soda —
113 Fuming Sulphuric Acid —
114 — Hydrochloric —
115 — Nitric —
112½ Hypochloride Soda + Alum equal

Saturday 14 April

116 Suspension in Chlorine

117

118 Sulphurous acid

119 Bromine vapor

120 Chloride Sulphur vapor

121 Oxygen Gas

122 Ozone

Ozone

Monday 16

124 Immersed in Ammonia Water
then suspended in Chlorine

125 Equal parts Ammonia water & Chlorine water

126 Immersed in
then suspended in Chlorine.

127 Immersed in Ammonia Water
then suspended in SO_2

128 Suspended in gas from Sulphuric & Nitric acid & Brush gross.

129 Immersed in Nitrate Potash Sol.
then in Chlorine.

130 Immersed in Nitrate Ammonia Sol
then in Chlorine —
Bleaches at once.

131 Immersed in Nitrate Soda Sol
then Chlorine

132 Suspended in Nitrous Acid

133 bottom half soaked in Nitrate Ammonia & top left dry
then all dried & suspended in Chlorine.

134 Immersed in Calcic Nitrate
then suspended in Chlorine

135 Immersion in Solution of Chloride Calcium & Alcohol

136 Ozonized Oxygen made with Prussiate Barium & Sulphuric Acid

Tuesday 17 April

137 Nitric Acid Vapour

~~138~~

139 Chlorine -

140 After heating in Nitrous Acid vapour immersing in Alcohol -

Dried spl. of 134. 138 & 15

141 Immersion in Prussiate Hydrogen & suspended in Chlorine

Dried electrolysis of water - N.G.

142 Ether -

Wednesday 18 April 1888

143 Suspension in equal quantities Chlorine & Nitrous Acid vapours

144 do do do -

145 Suspension in Nitrous Acid -

146 Nitrous Oxide -

Dried suspending in Chlorine water

Passing current through with Pt Elect.

do do in Chloride Lime water

do do in Nitrate Ammonia solution

147 Suspension in sulphurous acid.

148 " " Chlorine & then in sulphurous acid -

149 Sprayed with 10% Caustic Soda in water & suspended in Chlorine.

Thursday 19 April 1888

150 Sprayed with 5% Caustic Soda in water & suspended in Chlorine

151 Sprayed with 10% Caustic Soda partially dried in air & suspended in Chlorine

152 Sprayed with 5% Caustic Soda partially dried in Air & suspended in Chlorine

153 Sprayed with 10% Caustic Soda & suspended in Chlorine

154 Suspended in Chlorine

155 Sprayed with 5% Caustic Potash & suspended in Chlorine

156 No 4 put in a damp cloth dampened with 5% Caustic Potash then Cl. longer piece.

157 Air dried (last sample) put in damped cloth as above & then Cl. Shorter piece.

158 Put in Chlorine without treating first

159 Soaked in tobacco water then suspended in Ether vapor then in Chlorine

160 Soaked in tobacco water hung in air to dry partially then suspended in Ether vapours and vapours.

161 Suspended in ~~NO~~ NO_2

162 } Ammonia poured into Bottle containing
162½ } remainder of Cl.
dipped in tobacco water & hung out to dry.

162 suspended in NO_2

163 Suspended in NO_2

Friday 20 April 1888

164 - Sprayed in Lime Water
+ Suspended in Chlorine

165 Stained + Suspended
in Chlorine -

166 Sprayed with Lime Water
+ Suspended in NO_2

167 Sprayed with Ammoniacal
+ Suspended in NO_2

168 Sprayed NH_3 + hung in
SO_2

Tried continuous stream of ozone
by passing current of air through
air space between 2 sets of Boiler
& induction coil plus blocking

Saturday 21 April 1888

Boiled Leaf in Peroxide of Hydrogen
Suspended 115 previously coloured
by Nitrous Oxide in Sulphuretted
Hydrogen.

169 170 171 172 Chlorine Gas.

173 Suspended leaf previously bleached by
NO_2 in Sulphuretted Hydrogen

Monday 23 April 1888.

174 Immersed leaf in Log Water
169 H_2SO_4

+ passed NO_2 into Solution
after 5 hours lighter in it but dull
175 Dry leaf suspended over Chloride of Lime

176 ——— heated ———

177 Sprayed with 5% H_2SO_4 + 4 oz Chloride of Lime

178 Sprayed with 5% Sulphuric Acid
+ Suspended in Nitrous Oxide

179 Sprayed with 5% Sulphuric Acid
+ Suspended in ~~Ammoniacal~~ Chlorine

tried 5% Hydro sulphuret Ammonia
Gas after Nitrous Acid vapour.
tried 5% do do.
180 Sprayed with 5% Nitric Acid
Sol + Suspended in Chlorine.
181 Sprayed with Peroxide
Hydrogen + Suspended in
Chlorine in sunlight —
182 Sprayed with 1/pt HCl +
Lookrom 1 23/pt ~~H2O~~ Alcohol
+ Suspended in Cl —
183 Immersed in 1/pt HCl
23/pt ~~Eth~~ Alcohol —
184 Sprayed with Peroxide Hydrogen
+ Suspended in NO_2

Tuesday 24 April 1888

185 Suspended in ozone made by
Phosphorus Slowly oxidized —
186 Suspended in Hypobromous acid
187 Sprayed with Peroxide Hydrogen
+ Suspended in Hypobromous acid
Tried 5% Ammonia Hydrosulphuret 1/7 alc
after suspension in Chlorine — NH_4
Tried 5% Ammonia Water bath +
then 5% Sulphuric Acid Water bath
on leaf previously suspended in
Chlorine —
Used Peroxide Hydrogen with small
quantity Black oxide Manganese to
liberate free oxygen —
188 Leaf in Sulphuretted Hydrogen
189 Immersed in solution Sulphuret
Potassium + Hydrochloric Acid dilute
in drops.

190 Peroxide Hydrogen & Burnt Manganese added to bring off Oxygen
Leaf suspended in this gas

191 Immersed in equal quantities Chlorine Water & Peroxide Hydrogen –

192 Immersed in Chlorine water & Acetate Potash –

193 Sprayed with 10% solution Acetate Potash & suspended in Chlorine.

Wednesday 25 April 88
Photographing Helping
194 Sprayed 10% Acetate Pot & suspended in NO_2

195 Fried (spec 162 grs) leaf suspended in NO (dried) ~~then~~ immersed in 10% Sol Acetate Potash.

196 Fried 181 grs Sprayed with Peroxide Hydrogen & suspended in Chlorine in Sol Acetate Potash 10% strong

197 Fried 181 with 20% Acetate Potash.

198 Dried Nitrous Acid cure in solution 10% Hyposulphite Soda

199 Dried Nitrous acid cure in Solution 5% Sulphite Potash.

200 Dried Nitrous acid cure in Solution 50% Bisulphite Soda –

201 Dried Nitrous Acid cure in Solution 20% Carbonate Potash

202 Leaf in solution equal part say 5% Oxalic Acid & Salt & 90% water

203 Leaf in solution 5% Sulphite Pot

204 ——— 5% Bisulphite Soda

205 ——— 5% Acetate Pot.

206 NO_2 vapor with Sat Sol Carbonate Potash shaken up as to neutralize Nitric Acid vapor
Leaf suspended –

207 Nitrous ~~[illegible]~~ Curve immersed in Peroxide Hyd & 10% Potassic Prussiate

208 Leaf immersed in Perox Hyd & 10% Ferrocyanide Pot

Thursday 26 April 1888.

209 Sprayed with Ammonia water & then with Peroxide Hydrogen N G. Photographing 2½ hours –

210 Made apparatus for obtaining Ozone from Oxygen gas by brush discharge When worked I found ozone oxidized Copper brushes instead of attacking leaf

Friday 27 April 1888

211 Tried same experiment but with Platinum brushes – – –

212 Sprayed with Peroxide Hydrogen & suspended in Oxygen (not Ozonized).

~~213 Immersed in oil of tar~~

213. Immersed in sol Nitrate Calcium Neutral

214 ——— acid –

215 ——— Peroxide Hyd + 5% Silicate Soda

216 ——— Peroxide Hyd 45 Water 50 Silicate Soda 5

217 ——— Water + Peroxide Barium with 1% Sulphuric Perchloric after leaf was put in —

218. Peroxide Barium oil Sassafras + Water –

219 Peroxide Barium Lactic Acid + Water.

220 Proscide Barium Water
& Glacial acetic acid –
221 Proscide Barium Glacial
Acetic Acid & Ether –
222 Proscide Barium & Ether
223 Part of tble 215 treated with
1% Proscide Barium Water
Saturday 28 April 88
101 Small bottle Oil of Tar –
102a — croton oil.
103a — oil of Anaden.
104a — Spruce –
105a — Camphor –
106a — Balsam Tolu.
107a — Fusil oil
108a — Succinic Oil –
109a — oil Juniper B
110a — Wormseed
111a Oil of Tansy
112a — Juniper Berries
113a — Thyme.
114a — Organum –
115a — Cubebs
116a — Origanum
117a — Piedmonts
118a — Mace.
119a — Hemlock
120a — Sesami –
121a — Orange –
122a — Olive
123a — Neatsfoot oil
124a — Sassafras
125a — Cod Liver oil
126a — Oleic Acid
129a — Cade oil
128a — Oil of Carui

129a Oil of Linseed
130a Succus Conii
131a Turpentine
132a Essential oil of
133a Boiled oil
134a Turpentine
135a Gasoline
136a Astral Oil
137a Deodorized Benzene
138a Rapeseed oil
139a Pippin Cider Vinegar
140a Cotton Seed oil
141a Deodorized Naptha
142a Creosote
143a Paraffin Oil
144a Silicic Acid
145a Tartaric Acid in Alcohol
146a Chloroform

224. ~~Dilute~~ Binoxide Nitrogen
225 Sprayed with Peroxide Hydrogen
& Suspended in Binoxide Nitrogen
226 Suspended in Nitrous acid vapour purified from Nitric Acid vapours.
227 In Hydrogen Peroxide with 2% Sulphuric Acid
228 In Hydrogen Peroxide with ~~2 drops~~ 1% Caustic Potash.
229 Mixed Nitrogen & Chlorine Gas. Leaf sprayed with Peroxide Hydrogen & suspended in above.
230 Leaf suspended in mixed N+Cl.
231 Leaf sprayed with 1% Caustic Pot & suspended in mixed N+Cl.
232 Leaf suspended in mixed N+Cl.

Monday 30 April 1888

147a Oil of Spike
148a — Laurel
149a — Citronella
150a — Cassia
151a — Cedar Lebanon
152a — Copaiba
153a Balsam —
154a Oil of Calamus
155a — Sweet Almonds
156a — Rosemary
157a — Rhue
158a — Birch
159a — Pear
160a — Fivewood
161a — Fennel
162a — Lemon
163a — Ylang Ylang
164a — Wintergreen

165a Pinus Sylvestris
166a Horseroot
167a Eucalyptus
168a Anised
169a Bergamot
170a Cypress
171a Tolu Balsam
172a Oil of Stone white
173a Oil of Stone black
174a Oil of Savin

All the Amides (Fatty) & NH2
Aniline Volume
Amides - Ammonium Organic
Tetra Ethyl Ammonium
Carbonate Ammonia Bi Carb Am.
175a Propylamine
176a Napthylamine
177a Pyridine
178a Picoline
179a Trimethylamine

Dry
Acetdiamine -
Acetonine.
Methylamine
Aniline ✓
Atropine -
Amylamine -
Ethylamine -
Glycocine -
Dipropylamine ✓
Picoline.
Collidine ✓

Tuesday 1st May 1888.

233 Sple of 162 boiled in sol. 5% Carbonate Ammonia water. Rots it & Darkens it

234 Sple of 162 in sol 1% Carb Ammonia & water. then in 1% Sol Sulphuric Acid & water —

235 Sple of 225 in solution 1% Carb Ammonia —

236 Sple of 225 in sol Alcohol & Tartaric Acid Did not lose color or taste acid, burnt too brightly —

237 Spl of 201 in Aniline oil NG (discolors)

238 — — — — — & Ether.

239 — — — Collidine NG discolors —

240 — — — & Ether then washed — in water..

241 — — — Aniline & Alcohol

242 — — — Collidine & Alcohol —

243 — — — Alcohol & Ether 2% Naphthalamine

244 — — — Alcohol. then in water

245 — — — Dipropylamine —

246 — — — In 1/4% Caustic Potash

247 Leaf suspended in & Water & Peroxide Hydrogen with 1/4% Caustic Potash.

248 Spl of 201 in Trimethylamine

249 Pyridine (2g 162 spk sm)
250. 250 spk in Picoline
251 251 spk in Naphthylamine
252 spk .225 suspended over Hydro-
-Iodic Acid -
253 Spk .25 immersed in watery
Solution Hydrochloric Acid —
say 2g acid 4 water - -
254 spk 162 immersed in watery
Solution Hydriodic Acid
say 2g acid 4 water.

180a Ether malonic 1/80
181a Ethylen monacetat
182a Ether Nitric
183a Ether Oenanthic
184a Ether Oxalicus
185a Ether Pelargonic
186a Ether Propionic
187a Ether Rhodonat Sulphocyanat
188a Ether Ex Salicylic
189a Ether Sebacylic
190a Ether Succinic.
191a Ether Sulfurat.
192a Ethyl Tartat -
193a Ether valerianicus
194a Ethylchlorat
195a Alcohol Allylic.
196a Alcohol Benzylic.
197a Alcohol caprylic -
198a Alcohol Cummin
199a Alcohol Octylic -
200a Acetal
201a Aceton Chloral
202a Ethylenalcohol
203a Ether Acetic -
204a Ether Butyricus Conc Opk
205a Ethylbenzol
206a Ether Caribonic -

207a Ether Caproic -
208a Ethylen Chlorhydrin -
209a Ethylen Chlorat
210a Ethyliden Chlorat
211a Zimtsaure Aethyl
212a Ether Cyanat
213a Ether dichlorat -
214a Ether Disulfurat
215a Ether Formicic -
216a Ether Hydrochlor Chlorat
217a Ethyl Dichloracetat -
218a Anisaldehyd
219a Anethol
220a Anisol -
221a Asepsol -
222a - Benzoylamin
223a Benzobutylic Alcohol
224a Zimmtsaure Aldehyd

225a Amylen -
226a Amylamine
227a Amylether -

Tuesday
April 2 1889

228a Acetatyl Amyl
229a Amylocyd Butyric -
230a Amylium Bromat
231a Amyl Chlorat
232a Amyl Cyanat
233a Amylocyd Formicic
234a Amyl Jodat
235a Amyl ~~Proportionic~~ Nitrat
236a Amyl Proportionic
237a Amyl Rhodanat
238a Amyl Sulfurat
239a Amyl Hydrosulfurat
240a Benzol & Red Benzoic
241a Benzyl Bromat -
242a Benzyl Bichlorat
243a Benzyl Chlorat

214a ~~Benzylchlorid~~ Isobuttersäure
215a Benzolmonochlorat
216a Benzolmonobromat
247a Benzonitrit
248a Benzophenon
249a Benzolsulphochlorid
250a 1849 Marshalls
251a Butyron
252a Butyrin
253a Butylnitroform
254a Butylchlorat
255a Caprylin
256a Carboneum Tetrachlorid
257a Carboneum Dichlorat
258a Chloropicrin
259a Diethylamin
260a Diethylanilin
261a Dichlorhydrin
262a Dimethylacetalcarbinol
263a Dimethylresorcin
264a Dioxymethan
265a Dipentin
266a Eugenol
267a Formamid
268a Furfurol
269a Guajakol
270a Hexylidat
271a Butylamin (iso)
272a Isobutylaldehyd
273a Butylmercaptan (iso)
274a Amylmercaptan iso
275a Butylessigsäure
276a Isobutylacetat
277a Ethyl Isobutyrat
278a Isobutyl bromid
279 Isobutylen jodid
280 Isobutylenbromid
281 Butylisochromat

282a Isobutylbutyrat
283a Isobutylisobutyrat
284a Isobutylchlorid –
285a Butyl iso formiat
286a Isobutyl formiat –
287a Isobutyl iodid –
288a Methyl iso butyrat –
289a Isobutyl nitrat
290a Butyl iso nitrit
291a Isobutyl nitrit
292a Isobutyl valerian
293a Propylacetat (iso)
294a Isopropyl Alkohol
295a Isopropyl Bromid
296a Propylbutyrat iso –
297a Isopropyl Jodid
298a Kresol meta
299a Kresol ana Kresol.
300a Methylamin –
301a Methyl acetat
302a Methyl acetessigäther
303a Methylanilin
304a Methylsaures Benzyl
305a Methyl Bichlorid –
306a Methyl Butyrat –
307a Methyl carbonat –
308a Methyl Chloroform –
309a Methyl Cyanid Acetonitril
310a Methyldiphenylamin
311a Methyl formiat
312a Methyl saures Salicylat Salicylat
313a Methyl propionat
314a Methylpropylketon
315a Methylsulfocyanat
316a Methyl valerianat
317a Mononitroparacresol
318a Nitromethan
319a Nitropentan
320a Nitrosodiäthylin
321a Nitrotoluol

322a Nitrocresylol meta
323a Nitrocresylol Para
324a Oenanthol
325a Piperidin
326a. Phtalylchlorid
327a. Propionitril
328a Propylaldehyd -
329a Propylbromat -
330a. Propylchlorat
331a Propyl formiate
332a Propylioded -
333a Propyl propionic
334a Propyl valerianic
335a Pseudobutyl Chlorid
336a Resineon
337a Sheron
338a Terpinol
339a Tetramethyl amon hyd sol
340a. Tetraethyl amon. hyd sol
341a Tolunol chloral
342a Tolual cromat
343a Toluidine meta

344a Trimethylen cromat
345a Trimethyl carbinol
346a Trimethylamin Hydrochlor.
347a. Xylenol meta
348a Xylol -
349a Xylidin -
350a Valeryl Chlorat

Gown account to Storeroom

Thursday 3 May 1888.

255 In fuel gas - (Sprayed walls)
256 (160) In sol Tartaric Acid Alcohol + walls + washed in walls.
257 (160) In sol 1/4 % Caustic Potash + walls -
258 In City gas (dry).
259 (160) In sol Tartaric Acid + walls + then in 1/4 % Caustic Potash

260 Hydrogen bottom wetted

Friday 4 May 1888

357a Pure Rubber only Asphalte –

352a $C_{17}H_{33}COOH$

353a $C_{10}(OH)_2$

354a SH_2

355a $C_3H_6O_6$ Sol

356a $C_2H_5(OH)$

357a $(C_2H_5)_2O$

358a Ether Petrolei from Baku ~~British Russia~~

359a Calcic Sulphate xx

360a Ammonic Carbonate

361a Ferrocyanide Potassium

362a $K_3Fe_2C_{12}$

363a Aq Calc Caustic

364a $(NH_4)_2S$

365a Fe_2Cl_6

366a Ammonic Sulpho Cyanid

367a – Ammonia Chlorid –

368a Barryta Mixture

369a $MgSO_4$

370a Lauricum acid

371a $\left\{\begin{matrix}COOH\\COOH\end{matrix}\right\}$

372a NH_4HCO_3

373a Allyl sulphocarbylamin

374a Allylenyl

375a Allylamin

376a Cumol

377a Cumidin Isopropylamide benzol

378a Pseudocumol

379a Cymol

380a Acid Salicylos

381a Acid Trichlorbutyric

382a Acid Undecylsaure

383a Acid valerianic
384a Acid propionic
385a Acid pyrotartaric acid
386a Acid dichloracetic
387a Acid Cresylic
388a Acid Boro Wolframic
389a Acid Capronic
390a Acid Caprylic
391a Chloroacetic acid
392a ~~Iron Chro~~ Chromic
393a Cadmium boro wolframic
394a Carbon bichloride
395a Schwefelsaurechlorhydren
396a Valeraldehyd
397a Kalium Lactic
398a Chinolin
399a Iodide Amyl
400a ~~Acid Phosphomolybdenic~~ Peroxide Hydrogen

204 Fried Spraying Hydrogen Peroxide + Ironing LNG
401a 75% Peroxide Hydrogen + 25% Sulphate Calcium Sol
402a 75% Peroxide Hydrogen + 25% Sulphate Magnesia Sol
403a 75% Peroxide Hydrogen + 25% Carbonate Ammonia Sol
404a 75% Peroxide Hydrogen + 25% Caustic Calc Aq
405a ~~75%~~ Peroxide Hydrogen ~~60%~~ 25% Sol Chlor ~~Ammonium~~ Barytes
406 40% Peroxide Hydrogen + 60% Sol Chlor Am
407a 75% Peroxide Hydrogen 25% Phosphoric water
408 75% Peroxide Hydrogen 25% Barytes Mixture

Saturday 5 May 1888

409a 95% Peroxide Hydrogen 5% Tartaric Acid.

410a 95% Peroxide Hydrogen 5% Calcic Nitrate Neutral

411a 95% — 5% Bichloride Hg

412a 95% — 5% Chlorate Pot.

413a 95% — 5% Stannate Soda

414a 95% — 5% Hyposulphite Soda

415a 95% — 5% Oxalate Soda

416a 98% — 2% Acetate Potash

417a 97 — 3 Nitre

418a 97 — 3 Potato Starch

419a 97 — 3 Chloride Zinc

420a 95 — 5 Citric Acid

421a 95 — 5 Ammonia Nitrate

422a 98% — 5 Boracic Acid

423a 97% — 3 Dextrin

424a 97% Peroxide Hyd. 3% Sulphate Alum.

425 a 95% — 5% Sulphite Potash

426a 95% — 5% Carb. Potash

427a 95% — 5% Natrium Nitrate

428a 95% — 5% Pyrophosphate Soda

429a 95% — 5% Bisulphite Soda

430a 95% — 5% Ammonia Hypophosphate

431a 95% — 5% Ammon. Nat. Phosphate

432a 99% — 1% Permanganate Potash

433 solution 1% Permanganate Potash in water

434 part of 145 immersed in 10% Hyposulphite Soda & water

Monday 7 April 1888

432 Alum — ~~not water of crystallization~~ crystallized

433 Alumen Natrix water

434 Alumina Pura Barytes water

435 Alumina Acetic water

474a Parabanic Acid water
475a Margarinic — Alcohol
476 Malic — water
477 Hippuric — Alcohol
478 Creosotinic — "
479a Chlorocrotonic Acid "
480a Gunnakauric Benzoic Alcohol
481a Ammon Fluorid water
482a Ammon Citric water
483a Ammon Gallic water
484 " Molybdenic ammonia water
485 " Oxalic water
486 " Sulphophenyl water
487 " Benzoic alcohol
488a " Boracic water
489 " Bisulphuric water
490 " Bisulphurous water
491 " Phosphoric water
492 " Rhodanic water

493a Ammon Nat Phosphoric water
494 Am — Wolframic ammonia water
495 Kalium Xanthogenic water
496 Nanaura Kalium water
497 Tartrate Potash water
498 Kalium Silicic Fluorid water
499 " Silicic water 319
500 " Sulphite water
501 " Phosphor water
502 " Oxalate water
503 " Fluorid water
504 " Hypophosphorous water
505 " Iodide water
506 " Nitrite water
507 " Citric water
508 " Bromid water
509 " Ethyl sulphuric water
510 Benzoic Alcohol
511 Bicarbonate water

572 Kalium Boracic water
573 " Bisulfate water
~~574 " Borate~~
574 " Borate hot water
575 Manganic Kalis Natrum water
576 Natrium Phenolic water
577 " Acetic water
578 " Benzoic alcohol
579 " Ethylsulfuric water
580 " Bromid water
581 " Butyric - water
582 Benzolsulphosaures Natrium water
583 Natrium isobutylsulfuric water
584 " citric water
585 " chlorat water
586 " chloric water
587 " Bisulfite water
588 " Bisulfate water
589 Hydrogen Sodium Carbonate water

590 Natrium Hypophosphis water
591 " Iodic water
592 " Nitrosum water
593 " " methyl sulfuric water
594 " Oxalic water sparingly
595 Mannit - water
596 Natrium Stannic water
597 " Salicylic water
598 Salicin water
599 Pyrophosphate Soda water
600 Phosphate Soda water
601 Sulphocarbolate Soda water
602 Magnes acetic water
603 Magnes benzoic water
604 " boracic water SO_4
605 " borocitric water
606 " chlorat water
607 " carbonic water

548a Magnes. chloricum Hydrochloric acid & water
549a — Hypoenglicowater
550 — Nitric water
551 — Silica

Tuesday 1 May 88

Finding Solvents for 432—551.
Putting in bag

Soaked tobacco leaves in WH_2
4 hours dried them by
hanging overnight ~~& then~~
~~Suspended in Chloroform~~
~~No 261~~

~~do do No 263~~

~~do do No 263~~ –

Wednesday 9 May 1888.

Suspended soaked leaves in Chloroform
No 261
do do No 262
do do No 263
~~264 Solution in Calcium Nitrate~~
264 Suspended soaked leaves in NO_2
265 – Solution of Calcium Nitrate acid
266 1 oz peroxide Mn^{2} by weight 3 oz fuming H_2SO_4 – boiled water previously with $Mn^{2}O_2$ to prevent metallic chlorides there might be
267 1 oz peroxide dark by weight & 3 oz H_2SO_4 fuming well agitated and then stood still for use tomorrow –

No 263 taken out of Chloroform & immersed in decoction of tobacco water –

268 1g Permanganate Barium –
3mg Sulphuric Acid
6g water –

well mixed & let stand for use tomorrow

+ Friday 11th

Thursday 10 May 1888.

No 269 (immersed leaf in solution of 266) precipitated Sulphuric Acid 267

270 – 268

271 –

332 Acetate Strontia water

333 Mannas Lactic hot water

334 – Sulpho Phenolic water

335 – Hypophosphorus water

336 Lithium Benzoic water –

337 – Boracic water –

338 – Chlorat water

339 – Citric water

340 – Ferro citric

341 – ~~Oxalic~~ Nitric water

342 – Oxalic water.

343 – Oxypolat water

344 – Phosphoric – water

345 – Salicylic water

346 – Sulpho phenylic water

347 – Sulphuric water

348 – Carbonate Am water

349 Calcium Acetic – water –

350 – Benzoic hot water –

351 – Bromat water –

352 – Butyric water

353 – Citric – water

354 – Chromic water

355 – Hyphosphorus water –

576 Olium Lactic hot water
577 Lactophosphorici
578 ——— oxalic (water?) —
579 phenylic water —
580 ——— phosphide water
581 ——— phospholactic water —
582 ——— phosphate m/ prod
583 ——— propionic water —
584 ——— saccharat water —
585 ——— silicic (prep) ——
586 ——— salicylic water
587 ——— sulphivlat by water.
588 ——— sulphurosum in sulphur gas mixt
589 Manganese Acetic water
590 ——— Benzoic hot water
591 ——— Boracic — water
592 ——— Carbonic — acetic hot sol
593 ——— Chlorat water

594 Chromate Manganese water
~~595 Citric~~
595 Manganese Hypophosphorici water
596 ——— Citric Hydrochloric Ac
597 ——— Lactic hot water —
598 ——— Nitric water —
599 ——— Oxalic in H_2SO_4
600 ——— Phosphor sol $NaCl$
601 ——— Sulphate, water —
602 ——— sulphophenylic water
603 Fer. Amm Chloricis water
604 ——— Prot Sulph water —
605 ——— Ammon Tartras water
606 ——— + Ammon Persulph
607 ——— + Potass Tartrat water
608 Mangan Citric water
609 Ferrid cyan/Calcium water —
610 Ferro ——— water

611 Aver Acetic water
612 — Albuminat by water —
613 — Benzoic water
614 — Boro citric hot water —
615 — Bromat water —
616 — Chloric Sus. water
617 — Citrate hot water
618 — Hypophosphorus water
619 — Lactic water
620 — Limat water
621 — Limat Mentholat
622 — Malic water —
623 — Phosphis in Am water
624 — Phosphoric dilute phosphoric acid
625 — Phosphis Lactic water
626 — Pyroxidric water —
627 — Pyrophosphoric ammonia water

628 Aver Salicylic water
629 — Sequichlorid water
630 — Succinic Ammonia water Sol.
631 — Sulphenylic — water
632 — Tannic acetic acid —
633 — Tartrat water
634 — Sulphide — In weak H_2SO_4
635 — Bismuth oxychlorat water
636 — Phosphoric sol $(NH_3)Cl$
637 — Nitric by water
638 — Citric water
639 — Carbonate sol $(H_3N)Cl$
640 — Subcarbonat Sol $NaCl$
641 Borogly cum water —
642 Acetate Cadmium water —
643 Bromat — water

644 Cadmium Chlorid water
645 — Carbonate Sol (NH4)Cl
646 — Nitric water
647 — Sulpho phenylic water
648 — Sulphuric water
649 Calcaria Nitric water
650 Carbazol alcohol
~~651 Cocain~~
657 Nitrotoluol alcohol
652 Iodoform alcohol
653 Phenyl antiseptic alcohol
654 Nitro Phenol para alcohol
655 Nitro naphthalin alcohol
656 Terpenhydrat alcohol
657 Phlorhlorida Fe water
658 Iron Sulphuric oxyd water
659 — Tetrachloride water

660 acetate Zinc water
661 Benzoic — water
662 Borax — hyperchloric Ac
663 Chromic — water
664 Hypophosphorus Zinc water
665 Lactic — hot water
666 Phosphoric — (water)
667 Phosphorus — water
668 Picrombric — water
669 Salicylic — water
670 Sulphocarbolic — water
671 Tannic — water
672 Sulphuric — ~~Hyper~~ ~~chloric~~ Ac.

673 Part 2 by Immersed in sol Picric Ac
neutralized with Ammonia
674 Part 2 by Immersed in alcoholic Sol.
Picric Acid & Ammonia

list sent to Showroom

675 Part of 26 leaf in alcoholic solution Sandarac

676 Leaf in alcoholic Sol Sandarac

677 Leaf in Sol Picric acid & ammonia

678 — in American Saffron Sol

679 Part of 269 ——

680 Part of 269 in Brazilwood Extract

681 Leaf in ——

682 Part of 269 in Fuchsie

683 Leaf in ——

273 } Leaf first soaked in water

274 } ½ hour partially dried

~~275~~ & suspended 36 hours in

~~276~~ Chlorine Gas - sprayed

~~277~~ with ½% ~~Soda~~ Caustic

Potash & water & hung in

bottle over water

Monday 14 May 1888 - - -

275. Soaked leaf in water ½ hour suspended it in air to partially dry it — hung it in Chlorine 36 hours - placed it in lamp bulb suspended by platinum wire & exhausted it in mercury pump -

276. Soaked leaf in water ½ hour put it through same treatment as 275 until bleached - Hung in open air for 1 hour sprayed with Caustic Soda solution & hung over water -

277 Placed leaf in inverted jar full of water & displaced water gradually Chlorine Gas

N G

Dried 275 in Edelman's air pump all the afternoon exhausting to a high vacuum + then letting in air + exhausting again + finally left it in all night

Tuesday 15 May 1888.
Cleaned and oiled air pump –
Took out 275 from receiver and put it in Gas oven to dry thoroughly. Washed acid although the smell was gone the taste was as acid as before + on ~~smoothing~~ burning it there was very acid smell – –
279 Put another part of 275 in air pump + continually exhausted receiver all that day left in vacuum all night.

278 Suspended leaf in Chlorine Dry

Wednesday 16 May 1888
Continued exhausting air pump with part of 275 ~~wasted~~ under glass all the morning until it had been subjected to the treatment for one day.
Sprayed with 10% Caustic Soda solution + hung in bottle over ~~water~~ Caustic Soda sol.

280 Washed in water, & hung partly dried + hung in Chlorine

281 do do

282 do do

283 a placed 280 under air pump + left in all night.

Thursday 17 day 1888.

283 Left 280 in Chlorine Gas 16 hours.
+ then exhausted repeatedly in air pump

Made saturated solution Sesqui chloride Iron precipitated ½ pint with dilute Ammonia water
washed precipitate thoroughly + filtered to get rid of water.
Mixed residue with Sesquichloride making basic Sesqui chloride Iron. Ther

Made solution 25% above solution
75% water + put in leaf

284 do do 15% solution

285 do do 10% —

286 do do 5% —

Friday 18 day 1888.

6 Gm Leaf in Iodonic Solution
Made Chlorous oxide with
3 pt Iodic acid
4 ~ water
2 ~ Chlorate Potash
·8 ~ Tartaric Acid ~

After heating up to 150°F.
gas came off vigorously —
Conducted it into water & obtained
golden yellow solution that bleaches
rapidly — Kept dark —

Dry
287 Suspended leaf in Gas — .
— Kept dark —

288 Immersed dry leaf in
aqueous solution

289 moistened leaf + suspended within the gas –

~~290~~ Made Euchlorine saturated solution in water – + suspended ~~in water~~ leaf.

290 moistened leaf in water + suspended it partly in aqueous sol of Chlorine acid partly in the gas above –

~~291~~ dry leaf kept in gaseous Chlorine acid 2 hours.

292 dry leaf in Euchlorine gas

293 – aqueous sol Euchlorine

294 Dilute aqueous sol "

295 – Dilute aqueous sol Chlorous acid

Saturday 19 May 1888.

296 Gaseous Hypochlorous Acid

297 Aqueous Sol

~~298 Gaseous~~

Made Red passing Chlorine over. Red oxide Mercury wont work

afterward prepared oxide Mercury by precipitating Bichloride Mercury with Caustic Potash dried + heated up to 200° C.

Substituted for Red oxide + collected gas by displacement.

298 Gaseous Hypochlorous Acid

Monday 21 May 1888.

Mixed Pentachloride Phosphorus + Chlorate Potash + heated in water bath -

299 Suspended leaf in Gasons' mixture -

300 Immersed in aqueous sol

301 Suspended in Gas -

Made quantity Chlorous Oxide and concentrated aqueous sol. also diluted solution.

302 Immersed leaf in water for 1/2 hour then in aqueous concentrated solution - for 1½ hours then in water for ½ hour + hung out to dry -

Tuesday 22 May 1888.

Made Chlorous Oxide and passed it into ~~aq~~ solution Acetate Potash + water in first Wolfe bottle + water in second Wolfe bottle -

303 Suspended Leaf in Acetate Potash Sol -

304 Dilute Solution Chlorous Acid Oxide in water

Made Chloric Oxide by fusing 1 pt Chlorate Potash + when cold adding 4 ~~pts of~~ H_2SO_4, gently raising the heat ~~up to~~ from ~~20~~ 60 F to ~~212~~ 212 F in 2 hours - Delivery tube cooled in water.

Explosion -

305 Leaf in Chloric Oxide

Wednesday 23 May 1888

~~305~~ Tried making Chlorous Acid passing it into aqueous Solution Caustic Potash - but after running it for about 20 min it Exploded -

Bleached with Chlorous acid Solution & electrolysis of liquid in 10 min - helped Dickson 2 hours.

Tried electrolysing aqueous Solution Chlorous Acid but did not bleach any quicker.

306. Leg in solution Acetate of Potash saturated with Chlorine

Thursday 24 May 1888

307 Immersed part of 3 min alcohol & water

308 ——— Alcohol -

Generated Chlorous acide & carried into solutions acetate alum, caustic potash, (solution of ammonia making chloride ammonia + tobacco decoction)

309 Immersed 3 min Solution Acetate Alum -

310 Chlorous acide passed through tobacco decoction

311 ——— do do Acetate Alum

312 ——— Ammonia water

313 ——— Caustic Potash -

Friday 25. May 1888

Continued passing Chlorous oxide through 310 311 312 313.

Tried 310 and found would bleach in 10 to 15 minutes it being an embedded solution –

314 Chlorous Oxide through Solution Hyposulphite Soda

315 Chlorous oxide through Solution Sulphite Potash

Tried immersing leaf in 310 & then in Equal quantities Peroxide Hydrogen & obtained Extract

Saturday 26 May 1888

316 Passed Chlorous oxide through very dilute Permanganate Potash solution

317 do through Peroxide Hydrogen

318 do ——— Solution Sulphite Iron

319 ——— ——— Sol Ammonia

314 produced cloudy liquid + white precipitate which won't bleach

313 won't bleach Darkens –

315 rather cloudy with precipitate won't bleach.

316 Dark brown precipitate no bleaching properties –

Monday 28 May 1888 –

320 Chromic acid in solution
Acetate Alum treated – Leaf in

321 Solution Chromic Acid –

322 do (dilute) –

323 Treated 321 with Hydr. acid Barium

324 – Trioxide Antimony

325 – Caustic Acid Alum

326 – Hydric – Bismuth

327 – red oxide Iron

328 – Iri oxide

329 – Peroxide Manganese –

330 – Oxide Lead

331 – Zinc –

332 – Peroxide Lead –

333 – Sol Nitrate Silver –

334 – Treated 321 with oxide Nickel –

335 – very small quantity Peroxide Barium

336 – – – oxide Iron (dirty)

337 – Finely powdered Iron

338 – – – oxide Cadmium –

339 – – Cobalt

340 – – Cerium –

341 – Hydric oxide Barium

342 – Blk oxide Copper –

343 – Anhydric oxide Chromium

344 – White oxide Antimony –

Tuesday 29 May 1888.
Made the very concentrated solution
Chromic acid
also dilute solution –

315 Placed leaf in concentrated solution
× warmed it
316 Bleached in 4 or 5 minutes
dodo do in dilute solution –

317 treated concentrated sol with Iodine
318 ——— Aniline Oil –
319 ——— Succinic Oil
350 ——— Bicarb Soda.
351 ——— Stannate –
352 ——— Ether –
353 ——— Benzole
354 ——— Chloroform
355 ——— Collodion.

356 – treated concentrated solution with Turpentine
357 ——— Benzoic Acid –
358 ——— Absolute Alcohol.
359 ——— Carbolic Acid
360 ——— Sulphate Iron.
361 ——— Arsenic –
362 ——— Silver
363 ——— Copper.
364 ——— ~~Lead~~ Zinc
365 ——— Lead –

Wednesday 30th – May. 1888
Decoration day

Thursday 31st May 1888.

3/6 Chlorous Acid solution mixed with Caustic Soda Sol

3/7 Caustic Pot Solution saturated with chlorous acid

3/8 Made Chlorate Potash for Expt 162

Friday 1st June 1888

Crystallized Chlorate Potash - Made Perchlorate Potash recrystallizing several times to ensure the purity of Salt

Made by fusing Chlorate Potash until it parted with 2 atoms oxygen then separated the Chlorate & Perchlorate

Saturday 2 June 1888

Showing visitors round during morning.

Finished Perchlorate Potash

Monday 4 June 1888

Made Chlorate Barium by passing Chlorine into solution of hydrated oxide Barium until saturated recrystallized separating Chloride from Chlorate

Tuesday 5 June 1888.
Made Perchlorate Copper by combining Perchlorate Potash & Chloride copper & recrystallizing separating the Chloride Potash.

Wednesday & Thursday 6th June
Generated Hydrofluosilicic Acid Gas & passed into water.
Above not strong enough.
Made Hydrofluosilicic Acid by combining Hydrofluoric Acid & Silica.
Precipitated Potash from Chlorate Potash leaving Chloric Acid.
Added Carbonate Baryta & filtered
Evaporated filtrate & weighed Chlorate Baryta obtained. Combined with sol Copper sulphate — filtered & evaporated.

Friday 8 June 1888
3/69 Made Chlorous oxide and passed dry gas into receiving jar with sples of NO_2 & NO_5 in it
3/70 Placed spl leaf of SiO_2 in solution 3/20 for 1 hour & hung out to dry
found that the part out of the water lost the gas
Suffered diminution of weight
Equally with the part immersed.
3/71 Immersed leaf in Chloride Magnesia.
Prepared Chloride Magnesia for 3/62.

Saturday 9 June 1881
Made Chloride Copper for 162
by passing Chlorine Gas
through ~~solution~~ Emulsion
[illegible] Chloride Copper & Water —
Made Perchlorate Copper by passing
combining Perchlorate Copper & Potash
Chloride Copper & Chlorine Proportions
& Crystallized it —
372 Used Chlorous acid into water,
[illegible] Chlorous acid into Same Solution
but found it would not bleach
quickly — it only [illegible]
& at the bottom

Monday 11 June 1881

Made fresh supply Chlorous Acid
371 Solution for accurately testing the
loss of weight during immersion of
leaf
372 Placed leaf weighing 3.670 grams
in Chlorous Acid Gas for accurately
testing loss of weight when ~~gas~~ leaf is
suspended in it —
Chlorate bleach on adding an
acid —
By heating finely powdered $KClO_3$ + excess
crystallised oxalic acid to 170° C will
produce Chlorine Acid gaseous +
Carbonic Acid —

Tuesday 12 June 1888.

Taken out 373 & weighed it
Found it weighed 4.100 gr –
Exposed it to strong sunlight –
& afterwards to Sulphurous
& Sulphuretted Hydrogen vapour
374 Dried suspending leaf in
moistened steam & Chloroform NG
375 Placed leaf weighing 3.880 gr.
in solution 374 after leaving it
374 hour in solution took it
out washed it placed in dilute
Solution Hydrogen sulphide
Afterwards washed & dried
in steam oven. weight when dry
3.650 gr

376 Immersed leaf in 373
& afterwards washed in
dilute solution of Ammonia,
Hydrosulphuret & again in
water –

Wednesday 13 June 1888.

378 Immersed leaf in solution Chlorine
Acid made by pouring Sulphuric
Acid on Chlorate of Potash under
water with small fragment of
Phosphorus & precipitated excess
H_2SO_4 with Barium Carbonate NG.
Cleaned and sealed air pump –
Made ~~H_2SO_4~~ H_2SO_4 concentrated solution
at 0°C

Thursday 14 June 1888 –

Fitted up steam apparatus with old ice cooler – – –

378 Prepared dro 5 sple in Cl_2O_3 Sol. + after washing saturated in H_2S

380 Steamed dro 5 sple for one hour immersed in Cl_2O_3 Sol for 1 hour, washed – immersed in bath H_2S washed immersed in bath NH_3 (dilute) for NG (ammonia having been too much)

381 Steamed dro 5 sple, immersed in dilute solution Ammonia water for 5 minutes, washed, and placed in solution Cl_2O_3 –

Friday 15 June 1888 –

382 Steamed for 1 hour placed in solution Cl_2O_3 after bleaching hung in SO_2 vapor.

383 Steamed for 1 hour placed in SO_2 vapor for 1 hour

384 Hung in steam vapor for 6 hours to enable the vapor to permeate the entire fabric of the leaf + introduced steam

384 Hung in steam 1 hour
In SO_2 1 hour
In bath Baryta mixture
to try & reduce that SO_3 N.G.
385 Hung in steam 1 hour
In SO_2 1 hour. In Baryta
mixture back & then in ammonia
water to bring & get back color N.G.
386 Suspended dry leaf in
Chloride Nitrosyl 800 fg
gently Heating Nitric &
Hydrochloric Acid together
387 Suspended steamed leaf
in Chloride Nitrosyl

Boiled rice water
vide Robert's process Bleaching with
Millegrains plants

Saturday 16 June
After ~~heating~~ steaming in oven
12 hours placed moist leaf in
Jar and ~~[illegible]~~ conducted
fresh Chlorine Gas for just
388 made. Bleached in 1 minute
& the chemical action made
the jar very hot.
389 Placed steamed leaf (12 hours)
in Methyl Chloride Gas.
Burned it Black.

Monday 18 June 1888
Filled up Chlorous Oxide on large scale using steam oven for steaming.

Tuesday 19 June 1888
Continued above passing in Chlorous Oxide into the oven & making it quite airtight

Eg. Electrolysed solution of Chlorous Acid until the colour was quite out of it
Then I immersed leaf in it
Eg. do do do do do but added few drops Hydrochloric Acid

Battery 27
Positive
Zinc Porous cup Zinc Chloride
Carbon ~~cup~~ Chromic Acid
Dissolved red lead in Glacial Acetic Acid

Battery 26
Position 12
Zinc Chromic Acid Porous cup
Carbon ~~Porous cup~~ containing
Lewis Lye.

Battery 26.
Position ~~12~~ 1
Zinc
Carbon cup Chromate Lead.
Bichromate Potash.

Wednesday 20 June

Steamed 1/2 to hosley & carried
gas into wooden gas & room with
glass front. Whole room very
hot at first

Battery No 2.

A	B	Lewis Lyle
75	64	
71	62	after 1/2 hour S.C. thro Ci
62	58	— 1/2
23	18	— 15 — S C direct
20	12	B attery 2 Ro 3

Grooved Lead Smeared on lead plate

A	B	Lewis Lyle
77	66	.6368 m.f 2 ohm
20	19	after 1/2 hours S C
15	13	— 15 —

Battery No 3
Duplicate of No 3
Placed something wrong with 3

a	B
75	62
73	60 after ½ hour S C through a
15	15 after 15 hours S C through a

Thursday 21 June. 1888
After battery No 3 was running ½ hour
Mn⁴ to add Chloride Lime

a	B	
40	40 at first	
54	53 after 1 minute	
75	62 after 5	
60	60	58 after short S C 6 hours

after 24 hours S C
B 20
15

Mark Hypochlorite Soda – with Lead

Porous cup Mercury & Arsenic amalgam for B tarnish & purple red –
Caustic + H_2SO_4
No 5

Zinc + Lead
Chloride Lime + H_2SO_4

a	B	
43	55 at 1st reading –	
67	57	
50	57	3 — after 1 min S C stopped

H_2SO_4 Unwells out the battery

No 5 made up as No 3

Zinc Lead
Potash + Chloride Lime –
Lead the cathode with finely divided Lead by Electrolysis –

a	B	
76	62	1st
72	60	after an current ½ hour

after 24 hours S C
B 20
15

Friday 22 June 1888 -

Battery 6 -

Porous cup containing Arsenic & Mercury amalgam & amalgamated copper rod. Outside cell Amalgamated Zinc & Sew. Liq.

A.	B.	
3	20	1st reading
22	33	after 5 m S.C
26	35	15
15	20	— 1 hour
+	40	— 12 hours.

Battery No 7 -

Porous cup containing Arsenic & Mercury amalgam. & amalgamated copper rod. Outside cell. Amalgamated Zinc 10% H_2SO_4 -

A	B	
8	30	1st reading (at once).
5	15	after 1 hour S.C.

Saturday 23 June

Setting up Battery table

Monday 25 June 1888.
Battery No 8.

Hypochloric Soda
Lead, Zinc –

a	B	
6	38	1st reading
4	31	after 5m S.C ~~the~~
3	35	after 30m S.C.
2	30	after 1 hour S.C

Zinc became coated with a yellowish white precipitate coating & there was a yellowish precipitate.

Battery No 9
Hypochloric Soda.
~~Lead~~ Zinc & Copper

a	B.	
6	55	1st reading –
5	53	after 5m S.C through
3	45	after 30m S.C.
2	38	after 1 hour S.C

Zinc became coated with a white substance & there was a white precipitate at bottom of liquid –

204.

Standard Modell battery

Lelonde Cell. Zinc Copper
Copper oxide Lewis Lye.

a	B	
11	53	1st reading
11	55	after 5m S.C 1hrs a
8	40	30m S.C.
1.5.	26	24hours S.C

2010

Lead coated with ~~chloride of lead~~ white coating by Chlorine oxide.
Zinc Amalgamated
Lewis Lye.

a.	B	
5	33	1st reading -
3	37	after 30m S C
2	16	45 - S.C.

Battery ran down after 1hour S.C.

Tuesday 26 June 88

Fitted up resistance for
Electrolytic action
Tried electroplating Tungstate Soda
to deposit Tungsten. N G
Tried do Tungstic Acid +
Hydrochloric Acid.

Battery 11
Solution Tungstate Soda
few drops H_2SO_4 Zinc Copper

a	B	
4	50	1st reading –
2	35	after 30m S.C
1.5	25	2 hours S.C.

Liquid is turned deep blue
by the H_2SO_4

Wednesday 27 June 1888
Battery 12
Zinc Copper Phosphoric Acid

A	B	
4	50	1st reading
2	42	after 10m S.C.
2	32	30
2	35	1½hr S.C

Battery 13
tried with Porous cell
containing Solution Caustic

A	B	
3	18	1st reading
5	5	after 30m S.C

Battery 14
Position 1
Zinc + Arsenic
Bichromate Potash
sulphuric acid
Water

A	B	
4	54	

Thursday 28 June 1888
Battery 14
Position 1
Zinc Amalgamated
Arsenic.
Bichromate Potash + H2 SO4 Sol.

Arsenic A	Zinc B	
54	73	1st reading
54	70	after 5m S.C.
53	74	10

With 21 ohm coil

Battery 15
Position 2

Zinc
Arsenic
~~Hypo Sulphuric Acid~~

put on 1-43

A	B	
88	78	1st reading 11 ohms 1.288 Op. Ed.
68	75	100 ohms resistance in
88	78	after 5m S C.
88	78	after 30m S C.
88	78	" 1 hour S C
87	77	" 1 3/4 hours S. C.
66	75	" " " 10 ohms in circuit
87	77	" 2 hours S. C.
81	75	" 3 " " "
~~55~~ 60	~~47~~ 45	" 4 " "

Battery 15
Position 3

Zinc
Graphite
~~Bichromate Potash~~ Lewis Lyf.
~~Acid~~

Put on 2-30

Battery 15
Position 3

Injury
Zinc plate amalgamated w/ Lewis Lyf.
encircling porous cell containing Carbon
in Solution Hypochlorite Calcium 29
Concentrated Chloride Cobalt

A	B	
80	88	1st reading
82	72	after 5m S. C
78	62	" 30 "
77	62	" 1 hour S. C
70	57	" 2 hours S. C
48	55	" 3 "

Battery 16 B
Position 2
Zinc Porous Cell Chromic Acid
Copper Lewis Liq
~~Porous~~
a B. Battery 16 — Position 2.45

Battery 16 —
Position 3
Zinc Amalgamated
Arsenic
Lewis Liq.

a.	B	
68.	58	1st reading
57	45	10m S C
54	40	30m S C.
50	39	1hour S. C.
51	38.	2 ———
50	40	3 ———

Battery 17
Position 4
~~Zinc Porous Cell Lewis Liq.~~
~~Copper ——— Chromic Acid~~
3-20.
Arsenic in Porous cell containing Chromic acid & Hydrochloric Acid —
Zinc in cell containing Hydrochloric Acid Sulphuric Acid

a	B	
62	62	1st reading —
59	60	~~10m S C~~ 5m S. C
30	50	30minutes S. C.
20	45	after 1hour S. C.
16	45	— 2hour S. C.

Battery 19
Position 5

Zinc Lewis Lyt - ~~[illegible]~~
Lead cup filled with Chromic Acid
Put on 4-10.

A	B	
70	63	1st reading.
64	60	45m S.C.

no good fell to zero after 1 hour

Battery 19
Position 6

Zinc in Lewis Lyt. Put on 4 ~~15~~ 20
~~Lead cup filled Chromic Acid~~
~~Sulphuric Acid 10%~~
Arsenic in Porous cup containing Arsenious acide mixed with Lewis Lyt.

A	B	
33	55	1st reading
35	55	5m S.C.
24	52	30
25	50	1 hour.

Battery 20
Position 9

Zinc — Carbon
~~Lead cap filled Chromate Lead~~
Bichromate Potash.

A	B
90	~~88~~
~~60~~	~~77~~ {with 10 ohms.
76	82
88	83 — after 20 m. S.C.
87	82 — 40

Battery 22
Position 9

Zinc in Perox. and Chromic Ac
Lead — Lead Pyr

Tuesday 3 July 1888.

Experiment for Crystallized Hydrated Peroxide Lead —
Made solution Acetate Lead.
Precipitated spongy Lead.
Dissolved lead in solution Chlorous Acid solution
Do in solution Acetate Potass & Chlorous Acid —
Litharge in Chloro Acid
—— Pyr ——
Red lead in Chloric — turns to Powdered Pb O2
—— — Perchloric turns to
Metallic lead in Peroxide Hydrogen

Battery 23.
Position 10.
Zinc Porous cup Lewis Lyt
Lead Chromic Acid.

Tuesday 10 July 1888.

Made PbO_2 by boiling Pb_2O_3 in dilute HNO_3
washed in boiling water (Hard powder)

1st Made PbO_2 by agitating PbO (scaly) in
Smoke
By H_2O.
(To be boiled in water)

2 Made PbO_2 by agitating PbO (powder) in
By H_2O
(To be boiled in water)

3 made PbO_2 by passing Cl through PbO scaly
Suspended in water
to be washed

4 made PbO_2 by passing Cl O through ~~[illegible]~~
solution a citrate lead to be washed

5 made PbO_2 by ~~passing~~ agitating Pb_2O_3
in By H_2O

[ITEM FOUND IN BOOK]

Solutions = (2)

25 pct by weight Sulphuric acid
75 " " " Water -

25 pct Vol Hypophosphorous acid
25 pct Vol Glacial phosphoric acid

20 pct Sulphuric acid, 15 parts glacial acetic acid; 75 parts water.

25 parts glacial acetic acid, 75 water

15 parts Common formic acid, 85 water

20 parts Sulphuric, 15 formic. 75 water

25 pct Common Soluble arsenic acid
75 water -

20 parts Sulphuric 15 Tartaric 75 H_2O

20 parts Succinic acid, 80 water

Same with all above a Zinc Electrode —

also in addition
25 pts Nitric acid 75 water =
also 40 pts acetate ammonia 60 water -

[ITEM FOUND IN BOOK]

Notebook, N-88-04-18

This notebook, which covers the period April-June 1888, is a continuation of N-88-01-19. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. Included are notes, drawings, tables, and calculations regarding meters, batteries, carbons, the magnetism of iron and of ore, the electrolysis of chlorine, clocks, phonograph motors, galvanometer constants, generators, lamps, electric power distribution, insulation, and photometer tests. There are also notes on an Armington and Sims engine, the electric light system at Llewellyn Park, and the levelling of the property for the Edison Phonograph Works. Attached to the inside back cover is an index. The front cover is labeled "Record Book No. 2." The spine is labeled "6[3]." The book contains 89 numbered pages. Some pages were removed before the book was paginated. Numerous graphs have been pasted into the book.

The index has been filmed first.

Armington & Simms engine - 4
Carbon res - 18
Clock - 21. 30. 31.
Exposure - 33. 79.
Edisons System - 46. 59. 67. 82.
Electrolysis chlorine - 71. 72. 73.
Galvanometer Constants. 34.
Galvanic type - 37. 40. 42. 43. 44. 47. 50. 62. 65. 67. 76. 77.
Leading mains - 13
Magnetometer - 11. 17. 21.
Levelling - 61
Magnetic induction - 35. 36. 38. 39. 40. 41. 44. 45. 46. 49. 50. 51. 53. 54. 55. 57. 60. 63. 66. 68. 69. 80. 81. 88.
Meters - 32. 34. 52. 82. 87.
Magnet Observations - 22. 23. 24. 25. 26. 27. 28. 29.
Multipolar dynamo - 79. 82. 89.
Photometer - 56. 58.
Platinoid - 16.
Phonograph - 10 - 55
Radiation - 4. 9. 12.
Rails, res of - 37. 40. 44.
Res of Glass - 76. 77.
Res of Ore - 6. 8.
Standard cells - 75
Troy bridge - 4.
Susceptibility of iron - 6. 7. 11. 14. 16. 18. 19. 20. 31. 77. 84. 85. 86.
Wires, heating of - 74. 75.

xE-178 N-88-04-18

Record Book

of observations

in the

Galvanometer Room

Edison Labor.y

Commenced 18th April 1888.

Concluded 5th June 1888

No. 2.

The susceptibility of several cylinders of iron of various qualities was determined as follows:—

All the cylinders were 1¾" (4·4) in diam.
" " " 6" (15·2) in length
so that their volume would be 231·2. Area 15·205

A rough brass cylinder was made to fit these and cotton covered wire 0·04" = 0·102 wound on it in one layer of 95 turns of 5" mean diam. The length of this solenoid was about the same as that of the iron cores.

Another brass cylinder and solenoid of two or three layers 10 long 5·3 internal and 6 external diam.

In the first series this second solenoid was slipped over the first, and connected to the terminals of a delicate astatic galvanometer whose figure of merit = 3.376×10^8.

A res: of 50ω (approx) in circuit with the dynamo and inner solenoid completed the (primary) circuit. The induced throw on closing the primary circuit was observed on the galvt.

When no core was in the coil the induced throws were

2/4
23·75
23·75 } 23·8

Temp: of room 70°F Dynamo pot. diff. 114

Ulster - iron core inserted. Marked end up.

263
260·5 } 260·4
257
261

Marked end down } 262·2 − 23·8 = 238·4

265
264·5 } 264
242·5

East - iron core inserted
Marked end (I.C) up.

250·25 } 248·6
248·
247·5

Marked end down } 248·8 − 23·8 = 225·0

249 } 249
250
248

East wrought iron core inserted, lost specimen, many blow holes
Marked end up.

220·5 } 217·2
215
216

Marked end down } 225 − 23·8 = 201·2

240
230·5 } 232·8
228

5% Manganese
Marked end up

200
185·25 } 191·75
190·

Marked end down } 192·3 − 23·8 = 168·5

199·75
190· } 192·8
188·75

10% Manganese (very hard specimen)

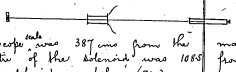
Marked-end up

57.5
55 } 55.8
55

Marked end down } 55.4 − 23.8 = 31.6

55.5
54.75 } 55
54.75

Tried the experiment with the aid of a magnetometer, using the Kohlrausch bifilar magnetometer for that purpose.



The telescope scale was 387 cms from the centre of the solenoid was 1085 from the magnet and current in solenoid as before (50 ω)

No ~~correction~~	0.315 divs = ~~0.595~~	0.630 cms deflection	
Ulster iron: marked end	towards mirror	3.14 = 6.28 cms	6.31 − 0.63 = 5.68
	away from	3.17 = 6.34	
East iron	towards	2.97 = 5.94	5.93 − 0.63 = 5.30
	from	2.96 = 5.92	
East wrought iron	towards	2.86 = 5.72	5.72 − 0.63 = 5.09
	from	2.86 = 5.72	
5% Manganese	towards	2.51 = 5.02	5.02 − 0.63 = 4.39
	from	2.51 = 5.02	
10% Manganese	towards	0.76 = 1.52	1.95 − 0.63 = 0.865
	from	0.735 = 1.47	

Taking Ulster iron as unity we have

	Induction method	Magnetometer method	Mean
East iron	94.38%	93.31	93.8
East wrought	84.39	89.61	87.0
5% Manganese	70.68	77.28	74.0
10% Manganese	13.25	15.23	14.2

No 1 Armington Simms Engine :-

Diameter 14·5" = 165 sq. in area

Diam rod 2·25" = 4

Stroke 15" = 1·25.

Back Const: $= \frac{165 \times 1.25}{33,000} = 6.250 \times 10^{-3}$

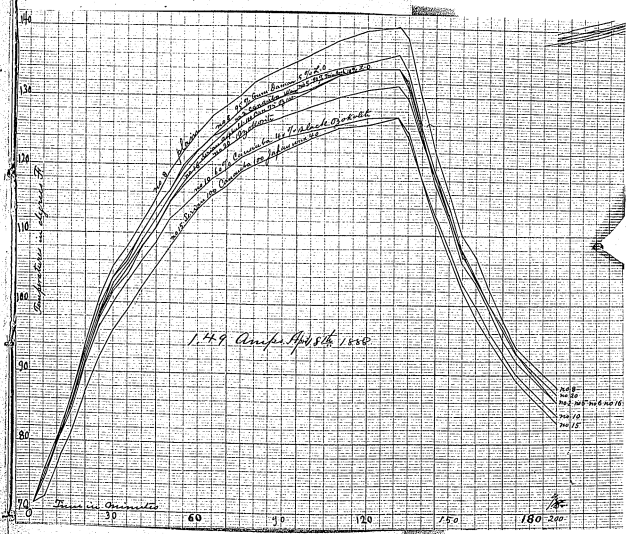
Front Const $= \frac{161 \times 1.25}{33,000} = 6.10 \times 10^{-3}$

At 14. 5. 4. 88 The speed being 250 revs : air press. by planimeter about 15 lbs.

The H.P. was reckoned at 46.

Took a comparatively rough determination of the temp: coeff: of the new Tay bridges. Tested B. by A. and then heated B. for about 3 hours.

B coil	@ Temp. =	A coil @ Temp.	B coil	@ temp	= A coil @ temp.	Ring Gr	K per °C.
1000	17.7°	999.75	1000	19.3	1003.93.35	3.50	0.025
100		99.96	100		100.08		
10		9.993	10		10.003		
10		9.992	10		10.039		
100		99.98	100		100.43		
1000		999.44	1000		1006.10	4.65	0.033
5000		4993.95	5000		5019.25	25.30	0.026
2000		1999.15	2000		2010.25	10.10	0.029
1000		999.25	1000		1005.45	6.30	0.025
1000		999.20	1000		1005.55	6.35	0.025
500		499.92	500		502.85		
200		199.92	200		200.85		
100		99.98	100		100.43		
100		99.98	100		100.32		
50		49.96	50		50.21	Mean	0.037
20		19.98	20		20.06		
10		10.00	10		10.06		
10		10.00	10		10.05		
5		4.97	5		4.99		
2		2.0	2		2.04		
2		[illegible]	2		2.04		


140
130
120
110
100
90
80
70
0
30
60
90
120
150
180
200
No 8
No 20
No 2
No 4
No 6
No 16
No 10
No 12
1.49 Amps April 5th 1900

Thursday 19th April

Measured the res: of a certain quality of ore.

1st Powdered and in a receptacle for a carbon telephone button transmitter so as to form a column 0·3 high and 1·75 in diam.
The res: was then observed to be about 0·6ω
The area being 2·376, the res: referred to unit area = 1·426ω and referred to unit volume = 4·752ω = spec: res: in ohms.

A small irregularly ~~solid~~ cubical block about 0·3 each side offered about 1300ω between the ends of two no 20. copper wire pressed upon opposite faces, corresponding to about 300ω say per c.c.

A solid block roughly a parallelopiped about 1"×1½"×½" was coated with tinfoil on each 1½"×½" side and the res: between the coatings observed to be nearly ∞.

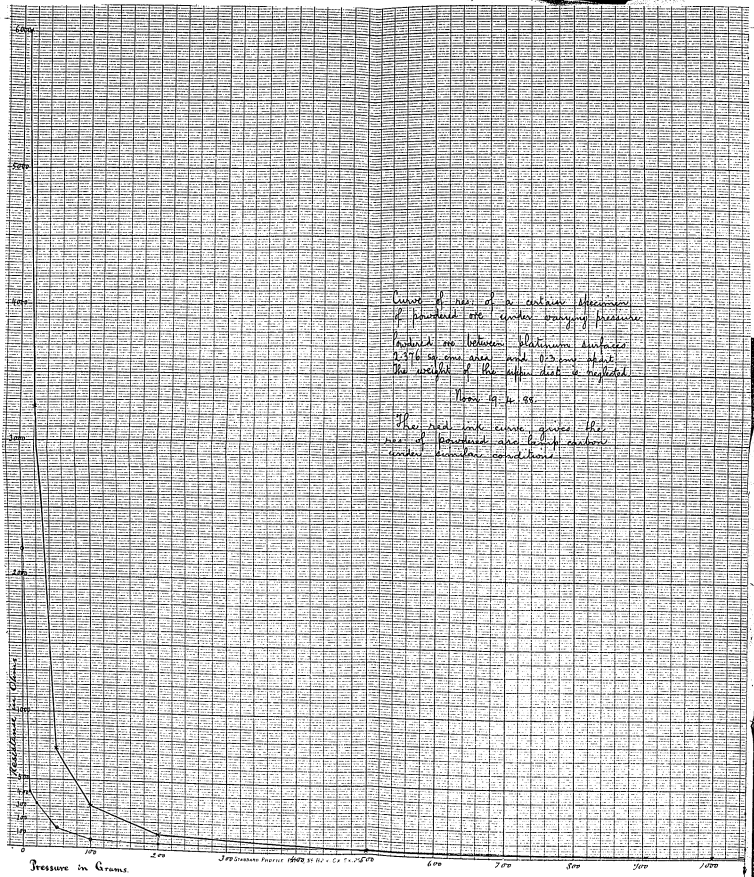
Some more powdered material was now poured into the receptacle and the res: measured. It was found to be very variable with the superincumbent pressure. The accompanying curve shows the reading.

Wound a spool with wire of following dimensions.

Length	Over all	$6\frac{5}{32}$	16.2
	Inter-flanges	6	15.25
Inner Diam. of cylinder		$1\frac{7}{16}$	4.46
Inner Diam. of spool		$2\frac{1}{8}$	or 5.4 cm.
Flange Diam.		$4\frac{1}{8}$	10.5

The wire was double cotton covered Diameter of conductor . of covered wire.

The first layer had		107 turns	and	D. 5.67
-	2nd	106	-	5.90
-	3rd	105	-	6.22
-	4th	105	-	6.48
-	5th	104.5	-	6.62
-	6th	105	-	6.83
-	7th	105	-	7.12
-	8th	105	-	7.40
-	9th	105	-	7.58
-	10th	105	-	7.75
-	11th	105	-	8.10
-	12th	105	-	8.48
-	13th	105	-	8.62
-	14th	105	-	8.90
-	15th	105	-	9.10
-	16th	104	-	9.40
-	17th	104	-	9.60.
	Total	1785		
	ave.	105.		

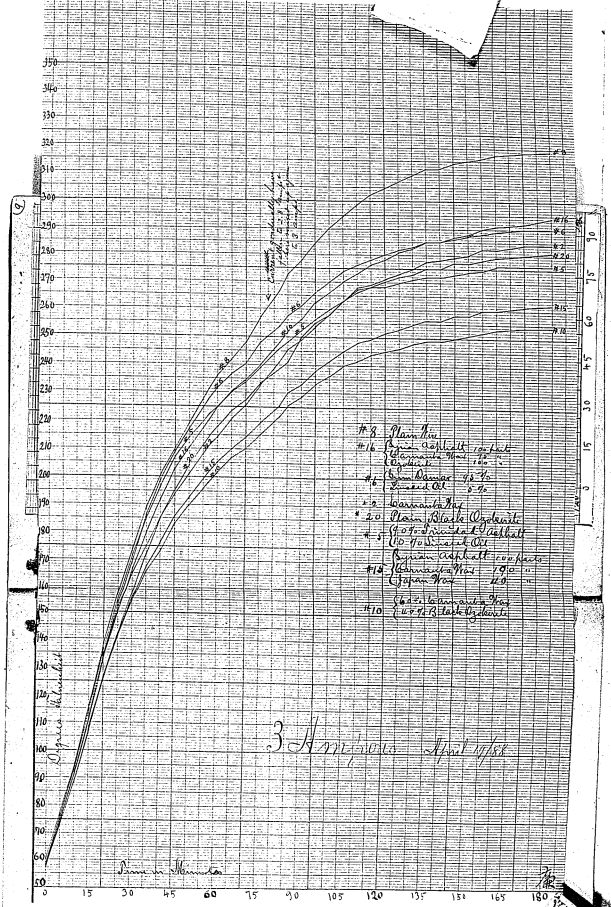


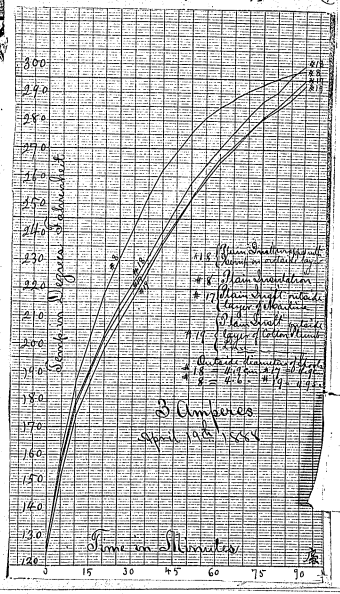
Curve of resist. of a certain specimen of powdered ore under varying pressure which was between platinum surfaces 2.376 sq. cms area and 0.3 cms thick. The weight of the upper disk is neglected.

Mon 9 p. 99

The red ink curve gives the resist. of powdered ore below under similar conditions.

B


Temperatur in Grad Celsius
Zeit in Minuten
0 15 30 45 60 75 90 105 120 135 150 165 180
60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350
#9 Planchen
#16 Asphalt 10 Liter
Benzin Wax 10 "
Carbolsäure 10 "
#1 Benzin Wax 15 %
Rüböl 85 %
#2 Carbolsäure Wax
#20 Planchen Wachs Carbolsäure
#3 Rüböl Carbolsäure
#10 Rüböl Carbolsäure
Benzin Asphalt 10 Liter
#12 Schmierseife Wax 10 "
Benzin Wax 10 "
#4 Schmierseife Wax
#10 L.V.V. Wachs Carbolsäure
3 Anzeichen April 1888


Temp. in Degrees Centigrade
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
0
15
30
45
60
75
90
Time in Minutes
3 Ambores
April 18th 1884
#18
#17
#19

Friday 20th April.

Owing to dampness of weather, reel of wire burst one flange, replaced it, and succeeded in obtaining a trial series with Norway iron.

The phonograph motors, have 4 magnets each of two spools of wire, each spool offering about 0·3ω and 6 layers of 40 turns or 240 turns. In one magnet there are thus 480 turns and 0·6ω. In two magnets arranged for quantity there will be 0·3ω. The working current is about 2 amperes or 960 ampere turns. Say that 1000 ampere turns are now needed.

As the magnets are now to be in series, the ampere turns in each spool are to be 250.

The winding space of each spool is
$(1{\cdot}77^2 - 0{\cdot}56^2) \times 0{\cdot}4854 \times 2{\cdot}17$ cubic inches $= 4{\cdot}80$
If d be the diam. of the wire now to be employed $4{\cdot}8\frac{d}{2}$ = length in inches.
The length of the mean turn $= \pi \times 1{\cdot}67$
The no. of turns $= \frac{0{\cdot}6}{d} \times \frac{2{\cdot}17}{d} = \frac{1{\cdot}302}{d^2}$
The res: of the wire $=$
If no 30 wire be employed its diam. is 0·012"
Its length on one spool would be $\frac{4{\cdot}5}{1{\cdot}20 \times 10^{-4}} = 30{,}000$ in
or 2500 feet. $\times 0{\cdot}072 = 180\,\omega$. Four such spools would offer $720\,\omega$ and the current would be $\frac{100}{720}$ or 140 millimpères. By counter EMF at 80 volts this would be reduced to 30 millimpères. The no. of turns $= \frac{1{\cdot}302}{1{\cdot}44 \times 10^{-4}} = {\cdot}9 \times 10^4 = 9000$.
The no. of ampere turns on each spool is therefore $9000 \times 0{\cdot}03 = 9 \times 10^3 \times 3 \times 10^{-2} = 270$.

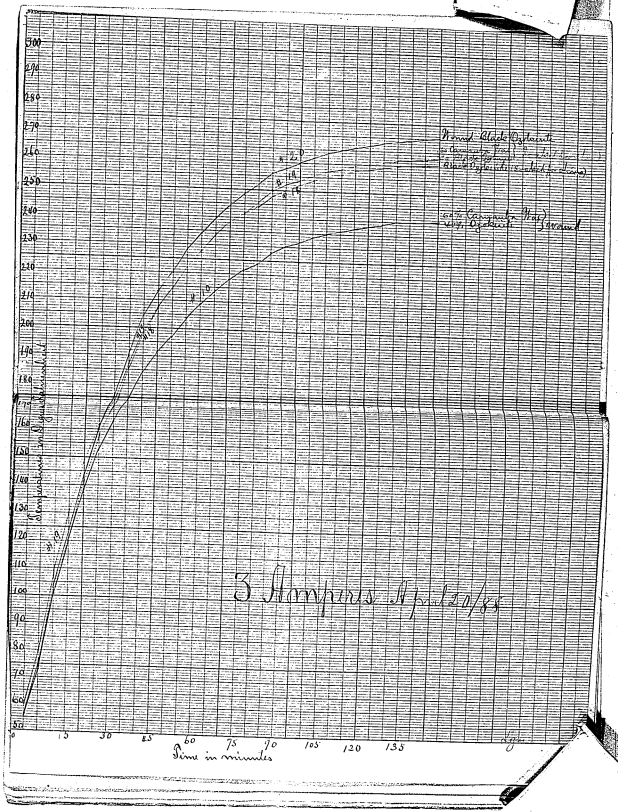
Measured the angles between the half silvered mirror of the portable magnetometer by means of the spectrometer, and made them

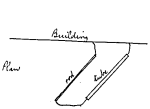
Between 1st + 2nd mirrors 11° 57′. 15″
- 1st + 3rd - 18° 32′. 00″

With the coil detailed on page 7
the exciting power from n amperes would be

$\frac{4\pi}{10} \times 1785n = 1.25664 \times 1785 \times n \quad 2243\,n$

This multiplied by k the coefficient for iron
$= 2243\,nk$
and the area of the iron face being 15.2
this becomes 147.5 nk lines per sq. cm.
Assuming $n = 3$ and $k = 32.8$ this expression
becomes 14,500 or about 80% of full ~~saturation~~


Normal Chloride Electrolyte
Temperature Range
Chloride Electrolyte Mixed to Dilute
64% Concentration Mixed Normal
Dip Electrode
Temperature in Degrees Centigrade
Time in minutes
3 Amperes April 27/85



Monday 23rd April

Measured the res: of a stick of carbon arc 0·1165" diam. 9·6 cms offset a res: of 7·5 approx. The diam being 0·296 cms, its area = 0·0688 sq. cms. Had its diam been 0·005" or 0·012 cm. its res would have been $\frac{7.5 \times 0.296 \times 0.0688}{0.012 \times 0.012}$ = 4000.

Tuesday 24th April

Tried an experiment with the view of localising grounded mains as follows.

An ordinary 20 foot 3 wire tube was set outside the building ~~in a~~ roughly horizontal and in the magnetic meridian as closely as could be estimated by the eye.

Some 20 feet away and parallel to the tube a copper rod about ½" diam was laid. The tube and rod were both supported about 2 feet from the ground on boxes.

The Dynamo current passed from the Galvr. mains out through one window to the tube, from the tube to the rod and from the rod back to the mains in the building after passing through an A.H. ammeter and a Siemens Dynr.

Banks of lamps in the Boiler room allowed the current to be controlled.

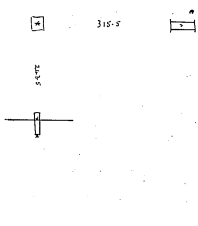
The following readings were taken.

No.	Coil	Amperes Act'l	Amperes Dig'l	Result	Resist: Ampes:	Dist: of Cube stone mill	Observed Deflect:	Calculd Deflect	Remarks
1	Tube	16	26·20	16·28	25	39	19°	22°·50′	Dist: slight
2	Rod	15·5	23°	15·17	-	52	17°	16°·50′	-
3	Tube	15·5	23°	15·17	-	41	19°	20°·50′	-
4	Rod	15·5	22°	14·83	-	52	17°	15°·25′	-
5	Rod	28	80°	28·3	50	52	29°·20′	28°·50′	Remained
6	Tube	28·5	77°·30	27·63	-	41	35°·20′	34°·50′	slightly.
7	Tube	28	77	27·5	-	41	35°·20′	34°·50′	Remained
8	Tube	28	76	27·6	-	41	35°·20′	34°·50′	"

The following experiments were made to determine the magnetic qualities of the iron cores.

The dist: from the centre of the magnet to the centre of the coil = 315·5

The dist: from the centre of the magnet to the centre of the scale = 243·5



Time Secs	C. 3.3 ambient temp.	Nottcutt Core	Nonney Iron	Ulster Iron	Cast Iron	Cast wrought	5% Manganese	18% Manganese
		secs						
0		0	−0.01	0	+0.15	−0.06	+0.01	0.0
1		0.12	+0.59	0.60	0.73	0.575	0.58	0.295
2		0.30	1.195	1.23	1.27	1.08	1.12	0.560
3		0.42	1.77	1.79	1.80	1.61	1.65	0.80
4		0.62	2.37	2.39	2.395	2.19	2.16	1.075
5		0.70	2.91	2.92	2.91	2.80	2.68	1.240
6		0.87	3.495	3.45	3.50	3.37	3.22	1.50
7		0.96	4.065	4.04	4.05	3.88	3.71	1.68
8		1.11	4.620	4.62	4.65	4.44	4.25	1.86
9		1.19	5.13	5.14	5.22	4.94	4.70	2.08
10		1.29	5.70	5.59	5.71	5.42	5.17	2.18
11		1.395	6.20	6.13	6.27	5.93	5.66	2.38
12		1.48	6.72	6.65	6.72	6.44	6.13	2.52
13		1.54	7.34	7.19	7.27	6.96	6.56	2.68
14		1.60	7.84	7.70	7.66	7.42	7.00	2.83
15		1.68	8.40	8.23	8.11	7.94	7.43	2.93
16		1.71	8.90	8.75	8.56	8.42	7.86	3.04
17		1.74	9.48	9.28	9.06	8.94	8.30	3.18
17½		−0.19	−0.09	−0.04	+0.10	0.18	+0.32	+0.30
300			−0.09	−0.07	+0.04	0.08	+0.08	+0.01

The res: per cm: of no 22 B.W.G. wire would be (0.072 cm diam) area 0.00407 sq cm

$= \frac{4.0 \times 10^{4}}{4.07 \times 10^{-3}} = 1 \times 10^{7} = 0.04\,\omega$ or about 1 metre to the ohm so for $120\,\omega$ we should require about 120 metres of the wire.

The res: of no 25 wire $0.020^{+} = 0.050$ cm $= 0.0020$ sq. cms area $= \frac{4.0 \times 10^{4}}{2.0 \times 10^{-3}} = 2 \times 10^{7}$

$= 0.02\,\omega$ or 50 cms to the ohm or 60 metres to $120\,\omega$

The res: of no 26 wire $0.018^{-} = 0.045$ cm $= 0.0016$ sq cms area $= \frac{4.0 \times 10^{4}}{1.6 \times 10^{7}} = 2.5 \times 10^{7}$

$= 0.025\,\omega$ or 40 cms to the ohm or 48 metres to $120\,\omega$

Wednesday 25th April.

From the results obtained on the 7th Mar: p. 49; the spec: res: of the platinoid wire @ per sample was 4.0×10^{4}.

The res: of one cm. of this wire of diam d. cms $= \frac{16.0}{\pi d^2} \times 10^{4} = \frac{1.6}{\pi d^2} \times 10^{5}$

The energy expended by a current of c units in traversing one cm. is thus $\frac{1.6c^2}{\pi d^2} \times 10^{5}$ ergs and the heat developed per sec. is

$$\frac{1.6c^2 \times 10^{5}}{4.2\,\pi d^2 \times 10^{7}} = \frac{0.381 \times 10^{-2} c^2}{\pi d^2} = \frac{3.81c^2 \times 10^{-3}}{\pi d^2}$$

$$= \frac{1.1126c^2 \times 10^{-3}}{d^2} \text{ 2. calories}$$

The energy radiated per sec. at 145° C. excess

$$= 45^{\circ} \times \pi d \times 2 \times 10^{-4} \text{ per cm.}$$

$$= 90\,\pi d \times 10^{-3} = 282744\, d \times 10^{-3} = 2.827 \times 10^{2} d$$

Equating these

$$1.1126c^2 \times 10^{-3} = 2.827 d^3 \times 10^{-2}$$

$$d^3 = \frac{1.1126 \times 10^{-1} c^2}{2.827}$$

$$= 3.962 \times c^2 \times 10^{-2} \text{ where } c \text{ is in amps}$$

$$\therefore d = \sqrt[3]{3.962\, c^2 \times 10^{-2}} =$$

say $\sqrt[3]{4c^2} \times 10^{-2}$ where

If $c = 1$ $d = \sqrt[3]{400} = 7.37 \times 10^{-2} = .0737$ cm

$$c^2 = \frac{d^3 \times 10^{4}}{3}$$

taking $d = 0.081$ $c = \sqrt{\frac{8.1^3 \times 10^{-2}}{3}} = \frac{5.88 \times 10^{-2}}{3} = \frac{5.88}{3}$

$$= \sqrt{2.7 \times 10^{-2}} = \sqrt{1.96}$$

$\sqrt{1.96 \times 10^{-1}}$ 1.5 approx.

The strength of field produced by one layer of wire is approximately.

$\frac{4\pi}{10} \times \frac{10.5}{15.3} \times 3.114$ or 27.37 H

Thursday 24th April

Adjusted the permanent mirrors of the portable magnetometer in such a manner that the large ones are within 20' of parallelism and each is within 20' of being at right angles to the central strip.

Also determined the angles of the strips to be :—

Upper and central . 6°. 36'. 30"

Lower - - 11°. 51'. 45"

The calculated values of the magnet readings p. 15

Coil Without Core :—

Coil	Current amperes	Magnetizing Force. H	Moment.	$\frac{\text{Moment}}{H}$
	3.7114	27.113	1.47×10^3	
2	3144	54.225	3.675 "	
3		81.339	5.145 -	
4		108.45	7.596 -	
5		135.56	8.545 -	
6		162.68	1.066×10^4	
7	×	189.79	1.176 -	
8		216.90	1.360 -	
9		244.02	1.458 -	
10		271.13	1.580 -	
11		298.24	1.709 -	
12	×	325.36	1.813 -	
13		352.47	1.887 -	
14		379.58	1.960 -	
15		406.70	2.058 -	
16		433.81	2.095 -	
17		460.92	2.132 -	
	out	460.35	~~439~~	439

No. of Circuits	Mean current Ampères	Magnetizing powers	Moment of coil reversal	Intensity moment volt.	Lines per sq. cm.	Susceptibility Nonmag.
1	3.1444	33.64	7.229×10^{3}	31.27	3.93×10^{4}	3.917
2		66.97	1.461×10^{4}	50.30	6.32×10^{4}	2.985
3		99.98	2.169	93.80	1.179×10^{5}	3.215
4		132.99	2.904	125.6	1.578×10^{5}	2.823
5		165.9	3.566	154.2	1.938×10^{5}	3.158
6		198.9	4.282	185.2	2.328×10^{5}	3.017
7		231.9	4.981	215.4	2.707	3.235
8		264.9	5.661	244.8	3.077	3.163
9		297.9	6.286	271.9	3.416	3.312
10		330.9	6.984	302.1	3.796	3.420
11		363.9	7.597	328.6	4.128	3.445
12		396.9	8.234	356.1	4.475	3.542
13		429.9	8.993	389.0	4.888	3.767
14		463.0	9.606	415.5	5.221	3.901
15		496.0	10.292	445.2	5.594	4.001
16		528.7	10.905	471.7	5.927	4.206
17		561.4	11.615	502.4	6.313	4.329
1	4.2667		7.351×10^{3}	31.80	3.996×10^{3}	4.001
2		?	1.507×10^{4}	65.18	8.191	3.100
3			2.193×10^{4}	94.86	1.192×10^{4}	3.262
4			2.928	126.66	1.592	2.854
5			3.578	154.75	1.944	3.172
6			4.227	182.8	2.298	2.966
7			4.950	214.1	2.690	3.209
8			5.661	244.8	3.077	3.163
9			6.298	272.4	3.423	3.320
10			6.819	296.2	3.723	3.334
11			7.511	324.9	4.082	3.395
12			8.148	352.4	4.429	3.494
13			8.810	381.0	4.788	3.670
14			9.443	408.1	5.128	3.814
15			10.084	436.2	5.481	3.900
16			10.721	463.7	5.827	4.118
17			11.370	491.8	6.180	4.334

Field coil	Current amperes	Magnetic power	Moment of coil + core	Intensity Moment + coil	Lines per sq. cm.	Susceptibility	Cast iron
1			8.982×10	38.69	486.1		
2			1.536×10²	67.49	845.6		
3			2.285×10	93.38	1178.5		
4			2.934×10²	126.91	1595.		
5			3.565	154.2	1932.		
6			4.288	185.5	2331.		
7			4.962	214.7	2697.		
8			5.697	246.4	3097.		
9			6.395	276.6	3476.		
10			6.996	302.6	3803		
11			7.681	332.3	4175		
12			8.232	356.1	4475		
13			8.906	385.3	4842		
14			9.382	405.9	5100		
15			9.936	429.8	5400		
16			10.029	433.6	5700		
17			1.116	480.2	6030		
		P.M. of 100	lines 1	sq. in. on	commencement of		Cast wrought
1			6398	27.29	343		
2			13,230	57.23	719		
3			19,720	85.30	1072		
4			26,820	116.1	1458		
5			34,300	148.4	1865		
6			41,280	178.6	2240		
7			47,530	205.6	2584		
8			54,390	235.3	2957		
9			60,520	261.8	3290		
10			66,400	287.2	3610		
11			72,648	314.2	3949		
12			78,894	341.3	4289		
13			84,892	367.3	4615		
14			90,845	393.0	4938		
15			97,260	420.7	5287		
16			103,170	446.2	5609		
17			109,470	473.8	5950		

Cycle No.	Current	Mag: factor	Moment	Intensity	Lines per sq. cm.	Inverse Intensity	(20) 5% Manganese
1			7105	30.74	386.22		
2			14945	64.64	812.		
3			20210	87.42	1099.		
4			26460	114.46	1438		
5			32830	142.0	1785		
6			39480	170.6	2145		
7			45450	196.6	2470		
8			52000	225.0	2827		
9			57,578	249.1	3120		
10			63,340	274.0	3443		
11			69,340	300.0	3769		
12			75,095	324.9	4080		
13			80,360	347.6	4370		
14			85,750	371.0	4665		
15			91,030	393.8	4948		
16			96,390	416.6	5234		
17			107.69	439.8	5527		
							10% Manganese
1			3614	15.63	1964		
2			6860	29.68	3730		
3			9800	42.40	532.7		
4			13,170	56.95	715.6		
5			15,190	65.70	825.6		
6			18,380	79.47	998.7		
7			20,580	89.01	1119.0		
8			22,783	98.53	1238.3		
9			25,481	110.22	1385.0		
10			26,710	115.5	1452		
11			29,156	121.6	1528		
12			30,870	133.5	1678		
13			32,830	142.0	1785		
14			34,670	150.0	1885		
15			35.890	155.3	1951		
16			37,240	161.1	2024		
17			38,960	168.5	2118		

Friday 27th April

Ascertained by compass measurement (11.99) and by cathetometer (11.966) that the 12cm line on the bar of the portable magnetometer was too close to the centre of the circle by 0.034.

By repeated adjustment, succeeded in obtaining the centre of the vernier to be also closer to the centre of the circle than the centre of the magnet by 0.038, thus almost entirely annulling the error.

Saturday 28th April

Obtained time at noon by wire from the W.V. office at Orange, recording the signals on the chronograph. The error of the clock appearing to be .21 secs. +.

Monday 30th April

Work the following observations of the value of H on the 4th pier, after removing iron from the immediate vicinity — with the Gauss instrument.

Torsion Reading small magnet.

$$\left.\begin{array}{l} \overset{\text{Pl. 1}}{+} = 0.\cancel{29}\,28 \\ \overset{\text{Pl. 2}}{-} = 0.29\,\cancel{28} \end{array}\right\} 0.27$$

Mean $-0.27 \pm 0.$ s.d.

Dist: of scale 289.5.

Magnet on		Pl. from	Obs.	
	a	N	− 11.59	~~11.595 +~~
	b	S	− 28.27	~~28.327 +~~
	c	N	− 28.34	~~28.34 +~~
	d	N	− 11.69	
	c	N	− 28.34	
	b	S	− 28.28	
	a	S	− 11.60	
	a	N	+ 11.66	
	b	N	+ 28.41	
	c	S	+ 28.30	
	d	S	+ 11.61	
	c	S	+ 28.28	
	b	N	+ 28.405	
	a	N	+ 11.69	
	a	S	− 11.535 ?	rejected
	b	S	− 28.22 ?	rejected
	c	N	− 28.33	
	d	N	− 11.69	
	c	N	− 28.325	
	b	S	− 28.30	
	d	S	− 11.605	

Zero correct.

Magnet on

a	d	b	c
− 11.59	− 11.69	− 28.27	− 28.34
− 11.60	+ 11.61	− 28.28	− 28.34
+ 11.66	− 11.69	+ 28.41	+ 28.30
+ 11.69		+ 28.405	+ 28.28
− 11.605		− 29.30	− 28.33
			− 28.325
11.629	11.663	28.335	28.319

11.646 28.327

Scale distant 289.5.

Vibrating Times.

Magnet swinging by its own fiber.

Torsion $\frac{\pi}{2}$ + 0·101
$\frac{\pi}{2}$ − 0·099 } 0·100 s.d. Distance 289·9.

238 complete vibs. of magnet in 2713·87"
or 11·4028" per vib.
amplitudes 4·2 —— 1·0 s.d.

Magnet loaded with brass ring weighing 167·279 and whose moment of inertia = 1087·31 cm. gms. Suspended by 5 fibers both fresh suspension, old one breaking.

Torsion readings

$\frac{\pi}{2}$ + 2·39
$\frac{\pi}{2}$ − 2·89 } Mean 2·595 s.d. Distance 289·9

10½ swings completed in 2588 secs or the period of one double vib = 24·8846"
amplitude 16 —— 10 s.d. Distance 289·9.
Temp 22°C.

The corrected time of oscillation for the unloaded magnet is

$\sqrt{\frac{5400+v}{5400}} \times (11.4028)^2$ $\therefore t^2 = \frac{5400+v}{5400}(11.4028)^2$

where $v = \tan^{-1}\frac{0.1}{289.9} = \tan^{-1} 0.000345 = 1'$

$\frac{5401}{5400} \times 11.4028^2$

log 11·4028 = 1·0570115
1·0570115
5401 = 3·7324742
5·8146 4772
5400 = 3·7323439
t^2 = 130·0148 2·1141031

The corrected time of oscillation for the loaded magnet is

$\sqrt{\frac{5400+v}{5400}}(24.8846)^2$ where $v = \tan^{-1}\frac{2.595}{289.9} = 0.00895 = 31$

$\frac{5431}{5400} \times 619.2433 = 622.7978$

The moment of Inertia of the magnet is thus

$$\frac{130 \cdot 0148}{622 \cdot 799 - 130 \cdot 0148} \times 1087 \cdot 31$$

$$= \frac{130 \cdot 0148 \times 1087 \cdot 31}{492 \cdot 75} = 286 \cdot 96$$

The time of ~~oscillation~~ oscillation being $\sqrt{130 \cdot 0148}$

$$MH = \frac{4\pi^2 \times 286 \cdot 96}{130 \cdot 0148}$$

$$= \frac{4 \times 9 \cdot 8696 \times 286 \cdot 96}{130 \cdot 0148}$$

$$87 \cdot 112$$

$\log 4 = 0 \cdot 6020600$
$\pi^2 = 0 \cdot 9942997$
$286 \cdot 96 = 2 \cdot 4578211$
$2 \cdot 0561811$
$130 \cdot 0148 = 2 \cdot 1141103$
$1 \cdot 9400708$

The corrected deflections are

$$\frac{5400 + v}{5400} \times 11 \cdot 646 \quad \text{and} \quad \frac{5400 + v}{5400} \times 28 \cdot 327$$

where $v = \tan^{-1} \frac{0 \cdot 27}{289 \cdot 5} = \frac{27 \times 10^{-4}}{2 \cdot 895} = 9 \cdot 326 \times 10^{-4} = \cdot 0009326 = 3''$

$11 \cdot 646 \left(\frac{5403}{5400}\right)$

$28 \cdot 327 \left(\frac{5403}{5400}\right)$

$\log 5403 = 3 \cdot 7326350$
$5400 = 3 \cdot 7323938$
$0 \cdot 0002412$
$- 11 \cdot 646 = 1 \cdot 0661768$
$1 \cdot 0664180 = 11 \cdot 6525$
$- 28 \cdot 327 = 1 \cdot 4522286$
$0 \cdot 0002412$
$1 \cdot 4524418 = 28 \cdot 3413$

$$\tan^{-1} \frac{11 \cdot 653}{289 \cdot 9} = \frac{11 \cdot 653}{2 \cdot 899} \times 10^{-2} = 0 \cdot 040197 = 2^\circ 18' = 0 \cdot 04013 \text{ Rad.}$$

$$\tan^{-1} \frac{28 \cdot 3413}{289 \cdot 9} = 0 \cdot 097768 = 5^\circ 35' \; 0 \cdot 09729$$

$R_1 = 50$
$R_2 = 37 \cdot 5$

$$R = \frac{\left(\frac{50}{2}\right)^3 \times 0 \cdot 04013 - \left(\frac{37 \cdot 5}{2}\right)^3 0 \cdot 09729}{25 \times 0 \cdot 04013 - \frac{37 \cdot 5}{2} 0 \cdot 09729}$$

$$\frac{125 \cdot 000 \times 0 \cdot 04013 - 527 \cdot 3414 \times 0 \cdot 09729}{25 \times \cdot 04013 - 18 \cdot 750 \times 0 \cdot 09729}$$

$$= \frac{5 \cdot 12875 - 41 \cdot 30530}{1 \cdot 00325 - 1 \cdot 82419} = \frac{36 \cdot 17655}{0 \cdot 82094} = \frac{44 \cdot 066}{2}$$

$$= 22 \cdot 033$$

$$\frac{M}{H} = 62{,}500 \times 0{\cdot}040013 \times \frac{2477{\cdot}967}{2500}$$

$$= 2486{\cdot}02$$

$$MH = 87{\cdot}112$$

log 2486·02 = 3·39550146
2·66777971 = 465·36 M
1·94000777 = 87·112 MH
T·27222866 = 0·1872 H

log = 1·94000777

(more correctly) =

$$\frac{\left(\frac{50}{2}\right)^3 \times 0{\cdot}040197 - \left(\frac{37{\cdot}5}{2}\right)^3 \times 0{\cdot}097768}{\frac{50}{2} \times 0{\cdot}040197 - \frac{37{\cdot}5}{2} \times 0{\cdot}097768}$$

$$= \frac{2512{\cdot}3125 - 2575{\cdot}2305}{1{\cdot}004925 - 1{\cdot}83315} = \frac{62{\cdot}92}{0{\cdot}828225}$$

$$= 75{\cdot}97$$

$$\frac{M}{H} = 62{,}500 \times 0{\cdot}040197 \times \frac{24224{\cdot}03}{2500}$$

$$= 2512{\cdot}3125 \times 4 \times 0{\cdot}2422403$$

$$= 10044925 \times 0{\cdot}2422403$$

$$= 2436$$

log 2436 = 3·3866773
87·112 = 1·94000780
2·66677993 = 1460·6
MH 1·94000780
T·27677004 = 0·1894 H

The strength of the magnet pole = 40·4
Intensity of Magnetisation 131·6
Lines to sq. cm. 1650.
Volume approximately 35·
Length 11·4
Breadth 1·12
Thickness 0·28.
Moment 460·6

Tuesday 1st May

following measurement for H at the 14th pair was taken with the small portable magnetometer. The swinging magnet consists of a tube of 3.3 × 1.15 inner diam 0.80. Its weight being 13.55.

The moment of inertia referred to a line perp: to axis is

$$13.55\left(\frac{(3.3)^2}{12}+\frac{(1.40)^2+(0.58)^2}{4}\right)$$

$$13.55\left(\frac{10.89}{12}+\frac{0.16+0.3306}{4}\right)$$

$$13.55\left(\frac{10.89}{12}+\frac{0.4906}{4}\right)$$

$$13.55\left(\frac{10.89}{12}+\frac{1.4718}{12}\right)$$

$$13.55\left(\frac{12.3618}{12}\right)$$

$$13.55 \times 1.03015 = 13.959 \text{ cm}^2 \text{ gms.}$$

The cylinder was loaded by a small brass rod 0.823 diam × 3.587 l. and 16.039g. Its moment about a line perp: to the axis

$$= 16.039g \times\left\{\frac{(3.587)^2}{12}+\frac{(0.4115)^2}{4}\right\}$$

$$16.039g \times (1.0722 + 0.04223)$$

$$16.039g \times 1.1145 = 17.876 \text{ cm}^2 \text{ gms.}$$

The periodic time of the unloaded needle was determined by chronograph to be 5.0665 but the torsion produced by $\frac{1}{2}$ was $\tan^{-1}\frac{0.265}{215.9} = .0012$ so that the correction is thus

$$\sqrt{t^2\left(1-\frac{4}{5400}\right)} = t\left(1-\frac{2}{5400}\right) = t(1-0.00037)$$

$$= 5.0665 \times 0.99963 = 5.0646$$

log 5.0665 = 0.7047080
0.7047080
5396 3.7320719
2.1412879
5400 4.7323959
t^2 25.65 = 1.4099921
5.0665 = 0.7047080

The periodic time of the bonded magnet was by chronograph 7.585

and the torsion due to $\frac{1}{2}$ was 0.33 or $\tan^{-1}\frac{0.33}{2159}$

$= 0.00152 = 5'$

log) ·33 = 7.518518
−) 2159 = 3342526
·1842613 = 0°5'

and the corrected time =

$\left(\frac{5395}{5400}\right)^2 = \frac{57.5322 \times 5395}{5400}$

log 5395 = ·7319914
log 7.585 = 0.8799556
0.8799556
·4919024
·5322938
− 5'

$= 5.7479$

corrected $t^{m} = 57.4789 = 7.595086$

The moment of inertia of the magnet

$= 17.876 \left(\frac{57.4789 - 25.6502}{57.4789}\right)$

log) 17.876 = 1.2522703
25.6502 = 1.4099941
2.661 3644
21.8287 1.3390338
1.3223306
= 21.005 cm²gm

$\frac{17.876 \times 25.6502}{21.8287} = 21.0051$

$M H = \frac{4 \times \pi^2 \times 21.005}{25.6502} =$

$\frac{39.47842 \times 21.005}{25.6502} = \frac{829244}{25.6502}$

$= 32.3289$

log π^2 = 9942997
− 4 = 6020600
3223306
9186903
·25602 4099941
32.3289 = 5095962

Deflections

N pole in a = 18.05 φ = 12°54.45
S - - b = 22.09 φ' = 6°36.30

S pole in a = 17.99 φ = 12°57.45
N - - b = 21.93 φ' = 6°36.30

Mean a = 18.02 Mean b = 22.01

$M = \frac{(18.02)^3}{2} \tan 12°57.45 - \frac{(22.01)^3}{2} \tan 6°36.30$

$9.01 \tan 12°57.45 - 11.005 \tan 6°36.30$

$29,257.3 \times 0.22842 - 53,126 \times 0.115851$

$2.05806 - 1.27494$

$\frac{6681 - 6,176.3}{0.78312} = \frac{505}{0.7831} = 64.5$

log 18·02 = 1·255754 8
1·255754 8
1·255754 8
9·35886 0
3·125586 46
0·3070300
2·8248316 6

668·1
617·6
50·5

log 22·01 = 1·3426200
1·3426200
1·3426200
4·06390
13·09176
0·3070 3
2·79076 = 617·6

log 9·01 = 0·9547248
9·35860
19·31332 48 = 2·058
1·275
0·783

log 50·5 = 1·7032911 6
− 783 1·8923732
2·8046182 = 63·6g

log. 11·0505 = 1·04159
9·06390
0·1054 = 1·275

The torsion of $\frac{\pi}{3}$ produces a deviation of $\tan^{-1}\frac{1·16}{253·25}$
= 0·0045 8 = 16″.

Correction = $\frac{54·46}{54·00} \times 12·8625'$ log tan 12·8625′ = 9·35860
0·001285
log 54·16 = 0·7336787 12·25′ 9·359885
54 = 0·7323938
0·0012849 9·36390
0·001285
6·38′ 9·06210 85

$$\frac{M}{H} = \frac{1}{2}\left(18·02\right)^3 \tan\left(2·54'\left(1 - \frac{63·7}{\cancel{324·7}\ (18·02)}\right)\right)$$

$$\frac{2926 \times 0·229064 \times 324·7 - 63·7}{324·7}$$

$$= \frac{670·47 \times 261}{324·7} = 538·7$$

$$\frac{M}{H} = \frac{1}{2}\left(22·01\right)^3 \tan 6°38' \left(1 - \frac{63·7}{22·01^2}\right)$$

$$= \frac{5331 \times 0·11629 \times 4844·4 - 63·7}{4844·4}$$

$$= 538·4.$$

log. MH = 1·5095962

$\frac{M}{H}$ = 2·7311857

4·2407819

M 2·1203909 = 131·9

MH 1·5095962

1·3892053 = 0·245

Particulars of magnet dimensions by Kathetometer

Length of cylinder	3·305		
External Diameter	1·158	Radius	0·579
Internal Diameter	0·820	"	0·410
Length of Collar	0·395		
External Diameter	1·397	"	0·6985
Internal "	1·168	"	0·584

The moment of inertia =

$$13\cdot55\left(\frac{(3\cdot305)^2}{12}+\frac{0\cdot579^2+0\cdot41^2}{4}\right)+1\cdot592\left(\frac{0\cdot395^2}{12}+\frac{0\cdot698^2+0\cdot584^2}{4}\right)$$

$$= 14\cdot037 + 0\cdot215 = 14\cdot252.$$

Accepting this value we have

$$MH = \frac{4\pi^2 \times 14\cdot252}{25\cdot6502} = \frac{39\cdot478442 \times 14\cdot252}{25\cdot6502}.$$

log = 21·935 = 1·3411376

$\frac{M}{H}$ 2·7311857

M^2 4·0723233

M 2·0361617

MH 1·3411376

1·3049789 = 0·2015

0·5 secs. of lost changed rate 10 secs. daily.

Clock Records.

Date	Clock error	Error	Diff.	Days	Rate	Watch error	Diff	Days	Rate
S 25	21 +					13 —			
T 26	13 —		34 —	3	—11	22 —	9 —	3	3 —
W 27	22·7 +		35·7 +	2	17·9 +	28 —	6 —	2	3 —
Th 28	33·5 —	Clock adjusted				37 —	9 —	1	9 —
S 5	20·3 —		12·2 +	7	12·2 +				
M 7	7·5 +		27·8 +	2	13·9 +	40 —	3 —	3	1 —
T 8	12·7 +		5·2 +	1	5·2 +				
W 9	30 +		17·3 +	1	17·3 +	50 —	10 —	2	5 —
F 11	40·3 +	Adjusted 8 min. down	10·5 +	1	10·5 +	63 —	13 —	1	13 —
S 12	53·5 +		17 +	2	8·5 +				
M 14	8 +		45·5 —	2	22·8 —				
T 15	16 —		24 —	2	12 —	50 —	13 +	6	2 +
W 16	22 —	Adjusted 8 min. down	63 —	1	63 —	47 —	3 +	1	3 +
F 18	66·8 —		44·5 —	1	44·5 —	53 —	6 —	1	6 —
S 19	72·3 —		5·5 —	1	5·5 —	55 —	2 —	1	2 —
M 21	81·5 —		9·2 —	2	4·6 —				
T 22	109·0 —	Adjusted 1 minute	20·5 —	1	20·5 —				
W 23	82·7 —	Adjusted	53·3 —	1	—	60 —	5 —	4	1·2 —
F 25	85·5 —		62·8 —	1	62·8 —	63 —	3 —	1	3 —
S 26	68·0 —	Adjusted	17·5 +	1	17·5 +	56 —	7 +	1	7 +
M 28	30·0 —								
W 30	2 —		48 +	1	48 +				
	Took down clock and relevelled plate.								
F 1 6.88	60 +		0			50 —			
S 2 6.88	73·8 +	13·8	13·8 +	1	13·8 +				
M 4 6.88	109·4 + 24·4	24 fast 24 h	36·6 +	2	17·3 +	68 —	18 —	2	9 —
	49 +								
T 5 6.88	54 + 60	Set back	5 +	1	5 +	68 —			
	6 —								
Th 6 6.88	Run down 9·25 +								
F 7 6.88	17·25 +		9·0 +	1	9 +	66 —	1·0 —	3	0·3 —
S 9	16·5 +								
M 11	22 +								
T 12	27 +								
F 15 6.88	26 +		8·75 +	8	1·46 +				
M 18 6.88	15 +		11 —	3	3·7 —	52 —	14 —	10	1·4 —
T 19 6.88	29·2 +		2·2 +	6	0·4 +	47 —			

Thursday 2nd May

Adjusted Clock so that the second hand reaches zero just about the moment the clock sends its minute signal so that the second mark following the minute signal at noon may be taken as clock noon.

The following may be taken as a resumé of the results obtained with the different specimens of iron

Ampere turns	Norway Iron	Plate Iron	Cast Iron	Cast wrought Iron	5% Manganese	10% Manganese	Paraffin + Iron filings
5000	100%	96.7	92.9	91.9	86.6	32.3	40.5
10000	100%	98.2	83.3	85.5	75.2	27.7	31.6
15,000	100%	99.0	78.9	83.0	69.9	28.8	29.2

Friday 4th May.

Took errors of Voltmeters as follows

			Error on 8th March
A. + P.	120 volts	indicates	3.6 +
A + P	150	"	4.2 +
Res: Cox	Hartmann & Braun	"	0.6 +
Door	"	"	3.25 +
Portable	"	"	3.7 +

Tests of a certain specimen of insulated wire from Schenectady in water.

From immersion 2/5/98 noon at 10v poly: to 50v
" " 3/5/ " " 100v " 200v

Took down the meters and after washing the plate in distilled water dried and weighed them.

No.	Weight Mar. 31st	Weight 4th May	Gain	Loss	
1	23.704	c 24.240	0.536		
2	24.542	a 24.007		0.535	
3	23.738	a 23.193	~~0.535~~	0.5435	
4	24.218	c 24.750	0.532	~~0.532~~	
5	24.164	c 24.715	0.551		
6	24.432	a 23.898		0.534	
7	24.853	a 24.327	0.	0.526	
8	24.380	c 24.902	0.522		
9	24.427	a 23.914		0.513	
10	24.130	c 24.693	0.563		
11	24.190	a 23.644		0.546	
12	24.057	c 24.642	0.5855		
13	23.799	a 23.258		0.541	
14	24.506	c 25.059	0.553		
15	24.825	a 24.278		0.547	
16	24.059	c 24.565	0.506		
17	24.018	a 23.479		0.539	
18	23.234	c 23.827	0.597		
19	24.358	a 24.896		0.538	
20	24.061	c 23.520	0.541		
		m		0.53625	

Exposure Experiments

33 Gravity cells having an assumed EMF of 36·3 volts and a measured I. R. of 14·0 ω were connected with the rheostatic bridge whose arms were $\frac{1000}{100}$ & $\frac{R}{E}$. To obtain 20 mas. the res. thrown in the battery circuit was $\frac{900 \times 36{\cdot}3}{20} - (140+90) - \frac{100}{11}$

$$:= 1650 - 230 - 14{\cdot}20 -$$

A number of plates made of different metals had been prepared approx. 1" sq. and 0·05" thick. One side of these plates was coated with shellac and an insulated copper wire ~~to~~ soldered to a side lug. The plates thus offered a little more than 1 sq. in. surface.

The cell was a battery jar 21 cms high × 15 cms in diameter. It was coated inside with a strip of copper sheet 15 cms high and reaching all round. A terminal on a raised strip of this formed the anode. The cell was then filled with distilled water up to the level of the strip top and salt (100 grms) added. This was all done by 18 o'clock.

At 20 o'clock the readings were taken. 20 milliamperes assumed to be passing. The exposures which were laid horizontal about 1 cm. below surface. Reading taken to immediate f.x.

Copper plate	15 ω	14·08 ω in cct.	5
Silver	12·9 ω		(6)
Zinc	7·6 ω		4
Aluminium	6·5 ω		(3)
Zinc repeated with poly.	6·8 ω		(7)
Copper	15·7 ω		(8)
Tin	12·3 ω		(5)
Iron	9·9 ω		(4)
Lead	6·6 ω	reducing to 5·9 ω	(1)
Nickel	34 ω		
2nd Plate Nickel	33·5 ω	(33·3)	(9)

The Constants of the various Galvanometers were calculated as follows:—

Obach Tangent 0·181 ohm: scale for 1 amp.
Ring " 0·137 or 7°·47′ per amp.
Gaugain " 1·3442 53°·21′ " "

S. Dynamometer thin coil. $0.857 \times \sqrt{\text{Tmin degrees}}$
Ayrton & Perry Ammeter 1 amp: indicated at 14·227
Long Ammeter indicates 0·5 when 5·13 cms from centre of ring or 9·75 on scale

Tested .5 meter boxes for electrical connexion as follows. 33 Gravities working thro the 5 meter in series direct, about $\frac{36}{1440}$ or 0·25 ampere flowing. The following deflections were obtained with the 5th bobbin galvr: and 2000 ω in its circuit acting as a shunt.

		check	Res. of coil
bobbin no 1.	547 divs:		32·325ω
" " 2	546 "	546	32·425ω
" " 3	546·5 "	547	32·285ω
" " 4	548 "	547	32·175ω
" " 5	548 "		32·335ω
" " 6	548·5 "		32·315ω
" " 7	549 "		32·495ω
" " 8	549 "		32·365ω
" " 9	550 "		32·175ω
" " 10	550 "		32·205ω

Temp. of Bridge 18·7° Room 16°

Res: of each cells shunt 0·04 ω.

Res: of a certain piece of stubb's steel 0·0063ω between points nearly ½" from ends, including res: of contact. $\frac{87}{500} \times 0.04 = 0.0063$.

The maximum divergence is thus

$\frac{550-546}{550} \times 100 = \% = \frac{400}{550} = 0.7\%$

Current passing thro meter bobbin $= \frac{0.04}{32.2+2+0.04}$ say $\frac{0.04}{34}$ or $\frac{1}{850}$

$\frac{430}{114.75} = 3.7473$ $\quad \log_n 3.7473 = 0.5736837$

$\quad\quad\quad

Time	Volts	Ohms added	7 cells on Pots	0·5 cells current	Interp. Diff. Amperes = Volts	Temp. 18°C	Unit tube a microcoulombs
10·24	–	–	–	0	0·20	7·5	
·33						7·25	0·041
·43						6·75	7·17
1·07	114·7	3 Temp. = 2·46	0·1 Ent.	0·1	190	8·5	2·13600
·10	114·6	"			238·5	9·7	0·0572
·18	113·6	-			2,534·40	10.	2·8000
·24	113·7		0·2	0·2	381	23·3	6·01
·30	113·8	55·7		-		23.	0·131
·37	114·14				478·8	21·65	23·45
·42	113·2		0·4	0·4	4,478·92	47·25	6·7020
·45	113·7	273			762	49·25	18·58
·50	114·				8,557·6	48.	0·277
12·09	114·9	110·2	7°·45'	1·0	10,768		14·5,000
·17	113·5		7°·47'	-	1905	113	2·793
·37	113·6	72·4	11°·36'	1·5	23,904	112·75	0·644
·43	113·14		"		2237	150·5	7·26
·46	113·7		-		3500	114·6	0·864
14·01	113·1	52·58	15°·17'	2·0	33,400	158·70	14·8000
·07	113·3		-		3810	172.	7·28
·15	112·25				47,88	172·75	0·988
·27	112·8	40·45	18°·52'	2·5	47,900	171	5·12300
·31	113·3		-		4762	182	11·000
·38	112·14		"		57,814	182	1·014·9
·48	112·5	32·4	22°·18'	3·0	5715	183·4	5·13000
·54	112·2		-			191	11·680
15·09	113·3				71,524	191·9	1·099
·10	112·1	28·96	27°·50'	4·0	66,827	191	5·9,300
·15	112·5		28°·50		7620	198·5	15,225
·22	112·7		28°·20'		85,76	197·7	1·141
·37	112·8	19·94	34°·20'	5·0	99,280	199·5	5·91600
·41	112·4		"		9225	202·2	12,703
·45	112·5		33°·50'			202·75	
·50	112·5		33°·40'		11969	200·25	1·165
16·03	111·5	16·4	39°·20'	6·0	11,496	201·0	6·01400
·09	112·1		"	-	11,420	210·75	13,970
·15	112·3		-	-	11,363	210·5	1·212
·17	113·2		39°·10'	-	1,337,650	212·4	6·21400
·25	112·1	12·4	43°·45'	7·0	13,335	210	13,490
·27	112·2		43°·20'	-	16757	215·75	1·244
·35	112·2		43°·30'	-	1,566,610	215·6	6·45000
·42	111·2	9·6	47°·20	8·0	15,260	218.	13,800
17·25	111·1		46°·20		1,8,151,4	227·75	1·258
·38	111·3	7·5	50°·45'	9·0	17,165	220.	6·23,300
·41	111·14		-		2,154·5	222	14,000
·48	111·8	6·3	53°·40'	10·0	19,872	221·5	1·273
					2,4,0,3	222·8	6·6,000
					2,320,482		1·230
					2,320,482		6·2,000

The curve dist: Interpolation indicated in 0·38 dist: curve each at 8 amp. at half angle at 0·5 amp. but although allowance had been made Equilibrium had not been reached. Survey 7°.

Tuesday 8th May

Res: between 2 iron rails buried in the ground at a depth of 2 feet. = 270 ω
Res: of one rail 0·09 ω

Following cells made up. Daniels type.

No 1.	FeO_4 and solution of	NH_4Cl
- 2.	Cu	
- 3	FeO	KHO 30%
- 4	antimony oxide common	
- 5	Cobalt	

Set the above to work about 11·30 on 7th.

	E M F	P.D.	C.	I.R.
No 1.	0·386	0·242	0·726	0·20
- 2	0·592	0·527	1·581	0·040
- 3	0·720	0·507	1·521	0·00
- 4	0·368	0·282	0·846	0·00
- 5	0·382	0·320	0·960	0·07

Set up two more

No. 6. White oxide of antimony + KHO 30% + NH_4Cl sat.
- 7 - - - -

15 o'clock

No 1.	0·192	0·144	0·432
- 2	0·474	0·410	1·230
- 3	0·740	0·426	1·278
- 4	0·280	0·242	0·726
- 5	0·305	0·248	0·744
- 6	0·712	0·478	1·434
- 7	0·604	0·316	0·948

17 o'clock

No 1	0·168	0·120	0·360
- 2	0·468	0·404	1·212
- 3	0·394	0·394	1·182
- 4	0·300	0·240	0·720
- 5	0·304	0·254	0·762
- 6	0·472	0·344	1·032
- 7	0·585	0·374	1·082

Set 4 sets of 5 Daniels cells to work on 1·4 ω each at 14 o'clock. Removed not.

$\log_{\frac{1}{2}} 3.8097 = 0.5808908 = \bar{1}.7640946$

$\quad 0.9388143$

$\quad \bar{2}.8252803 \quad .066578$

$3.8644 = 0.5870321 = \bar{1}.7686995$

$\quad 0.9388143$

$\quad \bar{2}.8298852 = 0.6759$

The Area of iron in the coils $S = 46.57$. $\frac{1}{S} = 0.021473$

d	$\frac{d}{S}$
0.5	0.010737
0.75	0.016105
1.0	0.021473
1.5	0.032210
2.	0.042946
2.5	0.053683
3.	0.064420
4	0.085892
5	0.107365
6	0.128838
7	0.150311
8	0.171784

Pendulum Observations.

λ.

10 Complete vibs in 349.15 secs. $T = 34.915$

$\lambda = \frac{1}{20}\log_e \frac{4090.5}{128.79} = \frac{1}{20}\log_e 3.8097 = 0.06488\ 1+\frac{1}{2} = 1.033439$

$34.915 \times 1.033439 = 36.083.$

10 Complete vibs in 348.7 secs $T = 34.87$

$\lambda = \frac{1}{20}\log_e \frac{456}{118} = \frac{1}{20}\log_e 3.86444 = 0.06759\ 1+\frac{1}{2} = 1.03388$

$34.87 \times 1.03388 = 36.051.$

Mean $T(1+\frac{1}{2}) = 36.067. \times 1.6 \times 10^{-6} = 5.7711 \times 10^{-5}$

Taking 7°.47′ as the deflection on the ring tangent corresponding to 1 ampere. $\tan = 0.1366866$.

0.1	= 0.0136687	0°.47′
0.2	= 0.0273374	1°.34′
0.4	= 0.0546748	3°.08′
1.0	= 0.1366866	7°.47′
1.5	= 0.2050299	11°.35′
2.0	= 0.2733732	15°.17′
2.5	= 0.3417165	18°.52′
3.0	= 0.4100598	22°.18′
4.0	= 0.5467464	28°.40′
5.0	= 0.6833330	34°.21′
6.0	= 0.8201196	39°.21′
7.0	= 0.9568862	43.44′
8.0	= 1.0934928	47°.33′
9.0	= 1.2301794	50°.54′
10.0	= 1.3668660	53°.48′

$5192 \times$ @ 18°.5′ $= .5182$ @ 18°.

@ 15°.C	=		+ 3	Tabulation	@ 15 °C.
		$\frac{5123}{5135}$		5123	
16°.5	=	$\frac{5163}{5175}$		5135	16°.5
				5163	
17°.5	=	$\frac{5163}{5175}$		5175	17°.5
				5163	
18°.5	=	$\frac{5124}{5136}$		5185	18°.5
				5124	
19°.5	=	$\frac{5252}{5264}$		5195	19°.5
				5252	
20°.5	=	$\frac{5211}{5223}$		5205	20°.5
				5211	
21°.5	=	$\frac{5332}{5344}$		5215	21°.5
				5332	
22°.5	=	$\frac{5263}{5275}$		5225	22°.5
				5263	

Time	Volts	Horizontal Deg. Cat. Ohms added 1.7	Indicated C	Current amperes	Amperes turns	Ohms Temp.	Ohms Cold 17.5°F	Q	Lines per Sq. cm. Tot. Flux
9.46				0	0	h		0.023	255.6
·51				0	0	h			
10.16	115.5		0.1	0.1	190	10.9	9.80	0.057	633.4
·22	115.1					9.			
·25	114.5					9.5			
·28	114.4					10.			
·34	114.7		0.2	0.2	381	17	15.00	0.104	1156
·42	114.7					15.75			
·47	114.6					16.2			
11.23	114.3		0.4	0.4	762	37.9	37.33	0.215	2389
·30	114.4					37.1			
·35	114.3					37.			
·49	113.8	112.23	1.0	1.0	1905	88.	85.5	0.493	5478
·59	113.7					85.6			
·55	113.4					177.0			
12.03	113.2					85.9			
13.17	112.8	73.3	1.35	1.5	2857	115.1	113.2	0.6648	7387
·20	113.1	73.3				114.5			
·23	111.2					116.			
·43	114.4	52.6	15.15	2.0	3810	140.	136.4	0.8114	9017
·46	114.5	52.6				140.4			
·50	114.1					141.6			
·57	114.0		19.55	2.5	4762	157.7	157.1	0.9078	10.088
14.04	114.2					157.1			
·07	113.2					157.1			
·13	113.8		22.20	3.0	5715	167.9	166.4	0.9724	10.806
·16	117.2		22.45			169.1			
·19	113.2		22.25			168.5			
·45	113.2	23.5	28.60	4.0	7620	177.6	178.2	1.028	11.423
·54	113.4		28.20			178.1			
15.12	115.6		28.40			178.9			
·19	115.7	19.9	33.50	5.0	9525	184.5	188.1	1.068	11.862
·25	115.1		34.15			185.9			
·28	114.2		34.40			185.			
·44	113.2	15.5	39.15	6.0	11430	194.5	198.5	1.117	12.412
·46	113.2	15.43	39.15			196.			
·48	112.2		39.10			199.9			
·58	113.0	12.4	43.20	7.0	13335	194.	198.1	1.126	12.512
16.02	112.9	12.4	43.45			194.1			
·09	112.8					195.5			
·15	112.3	10	47.35	8.0	15240	199.5	198.4	1.1646	12.712
·22	113.2		46.35			197.8			
·27	113.1		47.15			197.4			
·39	112.6	8.09	50.45	9.0	17145	201	201.5	1.160	12.890
·43	112.9		53.45	10.0	19050	205	204.5	1.189	13.213
·48	109.9		53.30			204.5			
·48	111.9		53.40			207.5			
·51			53.50			207.75			

log 4·06813 0·6093916 = T·7844896 44
0·9398143
2·6460921 = 0·070159

log 4·2929 0·6327508 = T. 8072328
0. 9398143
2. 6624185 = 0·072848

Wednesday 9th May

8.20

	No.	P.D.	EMF	C.	J.R.
	1	0·070	0·124	0·372	
	2	0·350	0·426	1·050	0·07
	3	0·240	0·303	0·720	
	4	0·240	0·302	0·720	
	5	0·236	0·298	0·708	
	6	0·290	0·394	0·870	
	7	0·105	0·350	0·315	
11.45	1	0·084	0·122	0·322	
	2	0·368	0·440	1·104	0·07
	3	0·252	0·303	0·756	
	4	0·250	0·296	0·750	
	5	0·242	0·294	0·726	
	6	0·294	0·396	0·882	
	7	0·108	0·343	0·324	
17.0	1	0·082	0·130	0·326	Removed
	2	0·350	0·466	1·140	
	3	0·252	0·284	0·756	
	4	0·250	0·296	0·750	
	5	0·246	0·294	0·738	
	6	0·296	0·396	0·888	
	7	0·100	0·314	0·300	Removed

Res. between buried rail 24 feet long & 3 feet apart after water had been poured on the surface of the soil 2 feet above them = 200 ω approx + polarizing

λ observations.

10 Complete vibs in 351·1 sec T = 35·11

$\lambda = \frac{1}{20} \log_e \frac{462.75}{113.75} = \frac{1}{20} \log_e 4.06813 = 0.070159 \quad 1 + \frac{1}{2} = 1.03508$

35·11 × 1·03508 = 36·341

10 Complete vibs in 352·55 sec T = 35·255

$\lambda = \frac{1}{20} \log_e \frac{462.75}{109.25} = \frac{1}{20} \log_e 4.2929 = 0.072848 \quad 1 + \frac{1}{2} = 1.036422$

35·255 × 1·036422 = 37·518

Mean = 36·920

Time	Volts	Ohms added	Current indicated	Current required	Temp 16°C. Amperes heater	Swing Phase	7° Conv. a	R.E.D. Ohms per sq. cm.
9.53 ·59 10.02 ·15	0	0	0	0	0	4 2.75 2 2.9	0.017	187.02
·27 ·34	113.3 114.4	4 Lamps + 2.	0.10	0.10	190	8.9 8.6	0.032	678.9
·49 ·52 ·55 ·59	114.2 114.2 114.2 114.7	1 Lamp +60.	0.20	0.20	381	20.2 17.5 16.75 19.4	0.109	1213.45
11.05 ·09 ·12 ·16	112.2 113.2 114.0 113.5		0.40	0.40	762	33.8 31.2 34. 32.5	0.194	2154.8
·26 ·30 ·39	116.0 112.5 112.2	112.2	50.50 7°.45 7°.40	1.0	1905	76 74.6 74.75°	0.444	4943.0
·50 ·54 13.17 ·22	112.0 112.5 112.5 112.1	73.3	11°.35' " "	1.5	2857	104.6 107.75 101.7 105.7	0.622	6924.7
·56 14.08 ·10	113.2 109.5 112.6	51.2	15°.25' 15°.05' 15°.20'	2.0	3810	130.8 130.1 134.25°	0.778	8661.5
·28 ·45	113.4 112.2	4.249	18°.55' 18°.50'	2.5	4762	152 151.2	0.896	9975.2
·54 ·59	111.8 112.2	33.37	22°.22' 22°.22'	3.0	5753	164.3 164.5°	0.978	10810.
15.07 ·12 ·21	9 111.8 112.4	24.9	21°.40' " "	4.0	7620	179.9 176.25 177.1	1.042	11601.
·30 ·36 ·39	112.6 111.8 112.2	19.91	34°.50' 34°.20' 34°.20'	5.0	9582	186 185.9 185.9	1.098	12224
·45 ·50	112.0 111.4	14.6	39°.25' 39°.20'	6.0	11506	191.5 192.	1.193	12619
·57 16.01 ·06	112.0 111.7 112.2	12.9	43°.40' 43°.40' 43°.15'	7.0	13260	194.4 196.5 196.4	1.155	12857
·19 ·24 ·31	112.2 111.2 111.2	9.7	47°.10' 47°.10' 47°.05'	8.0	15230	199.25 199.75 200.	1.190	13137
·38 ·43 ·54	110.7 111.2 109.4	7.6	51°.05' 50°.30' 50°.25'	9.0	16970	205.9 204. 204.	1.203	13393
17.00 ·05 ·09 ·14	108.9 111.2 111.5 111.5	6.16	53°.30 54°.15 54°.30 53°.40	10.0	19260	206.9 208.7 207 210.75	1.231	13705

Thursday 10th May.

Much inconvenience from leakage in pendulum apparatus. Dismounted and altered all connections.

Experimental cells. 8.20.

No.	Hours for start	P.D.	EMF	C.	S.R.
2	45	0·350	0·436	1·050	0·07
3	"	0·230	0·284	0·690	
4	"	0·250	0·308	0·750	
5	"	0·237	0·290	0·711	
6	"	0·270	0·360	0·811	
7·30 2	54	0·346	0·428	1·038	0·08
3	"	0·240	0·290	0·720	
4	"	0·262	0·310	0·786	
5	"	0·248	0·290	0·744	
6	"	0·272	0·364	0·816	
8	0	0·451	0·600	1·353	

No 8 cell set up ~~Zinc~~ Cu|Cu Amm. Bromide sol.
" 9 Cu|Cu Amm. Nitrate.
" 10 Cu|Cu Zinc Acetate.
" 11 Cu|Cu Zinc Chloride.

" 12 Cu|Cu ~~Strontium oxide~~ NH_4Cl
" 13 $Cu|Cu_2$ Strontium oxide
" 14 $Cu|Cu_2$ Strontium Chloride
" 15 Cu|Cu Sodium acetate
" 16 Cu|Cu Sodium Chloride
" 17 Cu|Cu Potassic acetate
" 18 Cu|Cu Potassic chlorate
" 19 Cu|Cu Ammonium carbonate.

Friday 11th May

9.0 No.	Hours for start	P.D.	EMF	C.	S.R.
2	69	0.330	0.426	0.990	
3	"	0.230	0.276	0.690	
4	"	0.252	0.310	0.756	
5	"	0.230	0.290	0.690	
6	"	0.260	0.342	0.780	
8	15	0.380	0.484	1.140	
9	0	0.228	0.424	0.684	
10	0	0.224	0.536	0.672	
11	0	0.440	0.540	1.320	
17.30					
2	75	0.304	0.406	0.912	
3		0.214	0.284	0.642	
4		0.240	0.276	0.720	
5		0.232	0.268	0.696	
6		0.244	0.326	0.732	
8	24	0.350	0.428	1.050	
9	0	0.200	0.410	0.600	
10	0	0.196	0.504	0.588	
11	0	0.382	0.456	1.146	

Saturday 12th May

9.30					
2	93	0.294	0.388	0.882	
3	"	0.218	0.254		
4	"	0.232	0.280		
5	"	0.214	0.270		
6	"	0.244	0.330		
8	39	0.320	0.414		
9	15	0.177	0.362		
10	"	0.188	0.480		
11	"	0.360	0.452		
13.15					
2	98	0.286	0.380		
6	"	0.247	0.328		
8	44	0.306	0.400		
11	20	0.358	0.458		
12	0	0.442	0.609		
13	0	0	0		

log 4·59635 = 66241 32 = T. 8211269
8211269 1·9388143
2·8823126 0·07626

log. 4·5722 = 66013 = T. 8196295
0·9388143
2·8808152 = 0·076

log 4·4986 = 6530774 = T 8144944
0·9388143
2·8761501 = 0·0752

Saturday 12th May

λ Observations.

1st 7 complete vibs in 250·15 secs T = 35·736
5 - - - 175·65 - T = 35·730

1st semiint 441·25 } λ = 1/25 log 4·59635 λ = 0·07624
2nd - 96 1+λ = 1·03813.

2nd 9 complete vibs. in 328·6 secs T = 35·622
5 - - 178·3 - T = 35·66
1st semiint = 435·5 λ = 1/5 log 4·5722 λ = 0·076
2nd - = 95·25 T×λ = 36·076 1+λ = 1·0380

Res: of magnet. 4·765 Res. of leads + app. 6·5; 3·16.
In measuring circuit a current was sent through the galvanometer and needle set swinging naturally. λ Reflected.

3rd 10 complete vibs in 356·5 secs T = 35·65
5 - - 178·25 - T = 35·65
1st semiint 410·5 } λ = 1/5 log 4·4986 λ = 0·0752
2nd - 91·25 T(1+λ) = 38·990 1+λ = 1·0374

Res: of circuit between buried rail
75ω = 0·34 ω per mile
12 volt at terminals would give approx 3·6 amp
12×3·6 = 43·2 Watts or about 1/5 H.P. lost.

Set up a new CuO NH4Cl cell no 12 also one with CuO in solution of strontium oxide

1630

No.	Hours from start	PD	EMF	e.	ΣR.
2	1 03	0·282	0·362	0·846	
6	103	0·240	0·318	0·720	
8	4 7	0·293	0·386	0·879	
11	2 3	0·340	0·434	1·020	
12	3 1/4	0·420	0·504	1·200	
13	3 1/4	0·0	0·04	0·	

$$\frac{n \times 36.978 \times 5225 \times 10^{2} \times 1.6 \times 10^{-4}}{46.57} = \text{Lines per sq. cm.}$$

$$\frac{n \times 3.6978 \times 5.225 \times 1.6 \times 10^{2}}{4.657} = 6.6381 \times 10^{2}$$

log	36.978	= 1.5679434
-	5225	= 3.718086 3
-	1.6	= 0.2041120
-	46.57	= $\frac{5.4901497}{1.6681062}$
		$\frac{3.8220435}{2}$ = 6.638×10^{2}

Time	Volts	Ohms	Current indicated	Current required	Amperes found	7" swing of Phasor	0.5 cm. a	E.D. T. 20°C	Lines per sq cm
10.58	-	-				- 2.5			
11.00						-2.25	negligible		
.23	111.4	3 [illegible]	0.1		190	8.25			
.25	113.3		0.1			9.5			597.4
.31	116.0		0.1			9.25			
.37	113.7	12 + 20.2	0.201		381	22.25			
.42	114.0		0.2015			22.9			1499
.50	113.8	12 + 6.2	0.40		762	43.6			
.52	113.2		0.40			45			2932
.56	112.9		0.40			43.9			
12.03	114.8	111.4	1.05		1905	107.1	103.1		
13.02	113.4		1.01			107.9	104.9		6945
.09	112.4		1.00			107.75	104.9		
.14	113.8	75.02	1.35		2857	141.9	138.9		
.18	113.4		1.35			142.5	140.5		9439
.36	113.5	54.78	2.15		3810	167.5	168		
.37	113.5		2.15			166.9	165.4		11,112
.38	113.7		2.10			169.5	168.7		
.47	112.5	42.25	2.70		4762	182.5	182.9		
.53	113.4		2.70			183	182.5		12,176
46.02	112.2		2.70			183	183.3		
.11	113.1	33.58	3.37		5715	190.75	190.5		
.15	113.0		3.37			190.5	189.5		12,679
.18	113.1		3.37			192	191.8		
.28	113.9	23.57	4.80		7620	208.90	208.9		
.31	111.3		4.80			208.5	207.5		13,447
.38	112.5		4.80			209.5	203.8		
.45	111.8	19.53	5.72		9525	207.75	207.9		
.51	112.7		5.72			209	209.9		13812
.55	112.2		5.72			207.5	207.4		
15.03	112.8	16.53	6.80		11430	214	214.15		
.09	112.7		6.80			210	209.9		14,069
.13	112.2		6.80			212.9	212.3		
.24	112.2	12.14	9.25		13,335	220.1	220.0		
.27	112.6		9.25			222.5	221.9		14,643
.31	112.2		9.25			220.9	219.9		
.39	112.1	9.97	11.25		15240	221.6	221.7		
.43	112.2		11.25			224.9	224.8		14,904
.48	112.1		11.25			225	225.1		
.53	112.4	7.82	14.00		17,145	232	231.1		
16.02	112.2		14.00			225.6	226.8		15,108
.05	112.7		14.00			225	224.9		
.14	108.2	6.26	17.25		19,050	234.25	234.7		
.16	112.4		17.25			228.7	227.7		
.26	112.2		17.25			222.4	221.9		15 208
.35	111.8		17.25			223	223.8		
.37	111.7		17.25			225	225.6		

Monday 14th May

Made following calculation of position of cross in Edison test system.

Res: of lead from Bridge on table no 1 to terminal board 0.079..

Res: of Wires and lead to engine room				two leads
	+	−	0.7145	0.6355
	+	0	1.0324	0.9534
	−	0	1.0310	0.9520
				2.541
				1.2705

+ Lead from Terminal Board to E.R.	+	0.3185		Library and Lecture room cut off at elevator.
−	−	0.3171		
0	0	0.6350		

Res: of Circuit composed as follows

Lead to Terminal board	0.079
Engine Room # − and 0	0.3171
	0.635
	1.031

Main neg: and Main neutral wire joined together at catch box on hill and to be distant 1780 feet.

Res	1.4795
Res. of Mains	0.44645

1780 feet of 0.00007149 = 0.1273 ω Main
1780 . . 0.0001827 = 0.3252 . Neutral
0.4525 ω −.44645 = 0.0079

The added Res: was 1000/1000 about 0.50 L Neg: = 0.4850 (Lead)
1000/100 9.45 . . = 0.4823
1000/10 99.0 . . = 0.4807
Accepted distance along Neg 0.4815

Lead L ~~E.R.~~ 0.0395
. E.R. 0.3171
0.3566

0.4815 − 0.3566 = 0.1249 ω
= Dist: of contact from E.R.
0.1273 − .1249 = 0.0024 ω # bw neg: side of catch-box.

Lalande cells.

9.45. 13. 5. 88

	M	Hours	P.D.	E M F	C	I.R.
NH_4Cl	2	118	0·325	0·420	0·975	
SbO_2	6	115	0·294	0·406	0·882	
NH_4Br	8	64	0·334	0·436	0·902	
ZnCl	11	48	0·290	0·410	0·870	
~~NH_4Cl~~	12	20	0·450	0·538	1·350	
		8.30. 14. 5. 88				
NH_4Cl	2	140	0·218	0·294	0·654	
SbO_2	6	137	0·320	0·390	0·960	
NH_4Br	8	86	0·236	0·308	0·708	
ZnCl	11	70	0·186	0·250	0·558	
NH_4Cl	12	42	0·320	0·390	0·960	
		13.30				
NH_4Cl	2	145	0·210	0·290	0·630	
SbO_2	6	142	0·220	0·320	0·660	
	8	91	0·232	0·304	0·696	
	12	47	0·320	0·380	0·960	
SbO_2	14	0	0·098	0·228	0·294	
NaCl	15	0	0·208	0·422	0·624	
NaCl	16	0	0·306	0·560	0·918	
KCl	17	0	0·312	0·572	0·936	
		17.30				
NH_4Cl	2	149	0·208	0·285	0·624	
SbO_2	6	146	0·224	0·320	0·672	
NH_4Br	8	95	0·234	0·308	0·702	
NH_4Cl	12	52	0·309	0·372	0·927	
ZnCl	14	5	0·142	0·208	0·426	removed
NaCl	15	5	0·174	0·274	0·522	
NaCl	16	5	0·227	0·296	0·681	
KCl	17	5	0·226	0·316	0·678	
$KClO_3$	18	5	0·318	0·440	0·954	
$KClO_3$	19	5	0·616	0·778	1·848	

$\log 5.27419 = .7221558$ $\quad \log = \bar{1}.8586200$

$\qquad\qquad\qquad

$$\frac{n \times 40.003 \times 5215 \times 1.6}{4.657} = 71.6.74$$

log 40003 = 0.602099 26
5215 — 0 717254 3
1.6 — 0.2041200
— .2231669
4.6657 — 1.6681062
— .8553607 = 71.674

time	Volts	Ohms.	Ind. E.	Equivalent current Amperes	Thrust	Corrected Thrust to Reg. E.	A.D. Mean.	0.7 mm. thrust for eq. amp	(49)
10.33	0	∞	0	0	0.0				
.30					2.8				
.43					2.75		2.68	192.1	
11.07	114.2	3 lamps	0.1	190.5	11.9	11.9			
.15	114.9	+236.2.	0.103		13.75	13.75			
.17	114.2		0.1		12.75	12.75			
.20	114.2		0.1		11.3	11.3	12.69	909.5	
.24	114.8	1 lamp	0.2	381	21.1	—			
.28	114.0	+315.2.	0.2		22.9	—			
.31	114.4		0.2		20.8	—	21.6	1548	
.40	114.9	?	0.3	571.5	32	—	32	2294	
.47	114.7	?	0.4	762	40.9	—			
.53	114.2	?	0.4		40.8	—	40.65	2914	
12.07	114.2	110.2	0.48707	1905	92.75	92.16			
13.16	114.4		0.13609		97	97.57			
.28	114.7		0.13468		96.75	104.455			
.32	114.2		0.13609		96.9	96.47	96.75	6934	
.52	114.3	76.18	0.20246	1.00276	132.8	130.81			
14.09	114.2		0.20196	2887	132.4	130.284			
.03	114.2		0.20497		132	132.04			
.07	114.4		0.20483		133.6	134.464	132.73	9513	
.12	114.3	52.98	0.27416	3810	164.7	160.23			
.15	113.9		0.27413		165.75	163.284			
.18	113.4		0.27414		165.	164.51			
.23	113.0		0.27416		162.3	161.81	163.42	11640	
.29	113.8	34.1	0.36279	4762	179	178.69			
.34	113.5		0.36270		179.75	179.24			
.41	114.1		0.36270		178.3	177.79	178.57	12795	
.47	113.5	34.09	0.41091	5753	191.25	190.99			
.53	113.8		0.41081		193	192.68			
.57	113.1		0.41091		190	189.65	190.71	13660	
15.04	113.7	24.25	0.52862	7620	199.25	198.57			
.09	113.7		0.52671		201.9	201.97			
.14	113.4		0.52673		202	202	200.32	14394	
.24	113.2	19.32	0.67763	9582	209.5	211.9			
.38	113.1		0.68304		209.75	209.98			
.41	113.3		0.68286		210	208.28	210.61	15095	
.45	112.4	15.09	0.81461	11506	213.6	213.64			
.53	112.3		0.81703		216.5	215.61			
.58	112.5		0.82140		210.9	210.9	214.29	15360	
16.02	112.4	12.53	0.97723	13240	219.75	218.53			
.06	112.5		0.97734		213.1	212.1			
.10	112.5		0.97771		212.4	216.03	216.22	15496	
.16	112.8	9.91	1.09245	15030	218.5	218.5			
.21	112.4		1.09245		218.7	218.7			
.25	112.8		1.09245		220.	220.			
.31	112.3		1.09245		220.2	220.21	219.52	15732	
.38	112.9	7.99	1.23183	16970	222.9	222.72			
.45	111.6		1.23758		226.9	227.38			
.55	111.5		1.23914		228.6	226.75	225.62	16170	
17.01	112.1	7.31	1.36800	19260	235.25	235.06			
.07	112.2		1.39148		230.7	231.92			
.11	112.7		1.39168		233.	234.22	234.73	16822	

log 4·88618 = 0·6889700 = 7·83820
0·93881
2·89939 0·07932 1·03961

log 5·314444 = 0·7254475 = 7·86063
0·92881
·92182 = 0·08352 1·04176
08137
04069

Pendulum Induction

Tuesday) 15th May

λ. A	10 complete vibs	in	382·75	=	T = 38·275
	1st 5		191·25	=	38·250
	2nd		191·50	=	38·310
B	10 complete vibs	in	389·95	=	T = 38·995
	1st 5		194·25		= 38·90
	2nd 5		194·5		= 38·90

Mean T = 38·590

1st series.

1st terminal 457·75 } $\lambda = \frac{1}{2}\log_e 4·88618 = 0·07932$
2nd 92·25 } $1+\frac{1}{2} = 1·03961$

3rd series

1st terminal 469 } $\lambda = \frac{1}{2}\log_e 5·314444 = 0·08352$
2nd 88·25 } $1+\frac{1}{2} = 1·04176$

Mean $1+\frac{1}{2} = 1·04069$

Mean $T \times 1+\frac{1}{2} = 40·160$

Lalande cells. 8·00

No.	Nature of Solution	Hours from start	P.D.	E.M.F.	C.	I.R.
2	NH_4Cl	164	0·190	0·274	0·570	—
6	SnO_2	160	0·206	0·312	0·618	
8	NH_4Br	110	0·215	0·276	0·645	
12	NH_4Cl	67	0·280	0·352	0·860	
16	NaCl	20	0·200	0·292	0·600	
17	K acet	20	0·190	0·296	0·570	
18	$KClO_3$	20	0·220	0·262	0·660	
1130 Aug 6	SnO_2	170	0·192	0·278	0·576	
8	NH_4Br	120	0·204	0·274	0·612	
12	NH_4Cl	77	0·249	0·324	0·747	
16	NaCl	30	0·148	0·294	0·444	
18	$KClO_3$	30	0·183	0·266	0·549	
19	NH_4ClO_3	0	0·034	0·277	0·102	
20	Na_2SO_4	0	0·183	0·447	0·549	
21	Brom	0	0·040	0·120	—	

Time	Volts	Ohms.	Sol. C.	Resy. corr. ambient temp.	Temp. 17°C Mean Ohms	Corrected to sol. c.	Corrected Mean Ohms	Log. Lumo for sol.	
11·23	114·9	32·+174	0·1	190·5	? 6·8	6·8	7·57	5144·7	
·24	114·9				8·6	8·6			
·35	115·0				? 7	7·			
·39	114·3				7·2	7·2			
·45	114·3	22+684	0·2	381	14	14	17·84	12844	
·48	114·7				? 17·4	17·4			
·52	114·8				? 18·4	19·4			
·58	114·8	12+46·1	0·4	762·0	32·5	32·5	32·6	23·46	
12·13	115·2				32·7	32·7			
·16	114·7				32·6	32·6			
·21	114·7	110·23	0·13758	1905	82	81·47	80·444	5788	
·25	114·4		"		79·9	79·37			
·29	114·6		"		81	80·47			
·40	115·0	73·57	0·20497	2849	110·1	110·13	107·99	7914	
·46	115·7		0·20608		110·6	109·82			
·56	115·0		0·20607		110·	110·03			
·54	114·5	53·14	0·27619	2.889	135·6	135·2	134·49	13743	
·57	115·6		0·27619		? 132·9	133·45			
13·03	115·7		0·28360		135	133·02			
·15	115·0	42·19	0·34109	4562	157·25	157·55	158·89	11,430	
·29	114·4		0·34108		159·75	160·05			
·33	114·3		0·33945		158·	159·06			
·41	113·2	33·57	0·40911	5755	164·6	165·09	168·69	12,138	
·45	113·2		0·40681		? 165·9	167·99			
·52	114·7		0·40671		164·44	164·09			
14·01	114·4	25·10	0·54673	7620	182·7	182·47	181·802	13,080	
·05	114·5		"		181·	+86·44			
·10	114·9		"		181·75	181·716			
·17	114·7	19·94	0·68524	9550	198·1	197·6	181·28	13,260	
·21	114·7		0·68301		195·2	195·27			
·25	115·6		0·68576		? 181·5	181·01			
·29	114·5		0·68301		181·5	181·59			
·37	114·5	15·94	0·84966	14,580	? 190·	190·12	189·97	13,670	
·46	115·1		0·82400		189·3	189·26			
·50	114·5		0·81966		193	193·10			
·54	115·5		0·82190		? 196·25	195·79			
15·00	114·7	12·65	0·95251	19,240	199	199·115	198·6	14,240	
·09	114·7		0·95251		196·9	197·34			
·15	114·8		0·95799		199·1	198·85			
·27	115·2	10·20	1·09179	23,080	201·5	200·71	202·4	14,660	
·29	115·2		1·09450		204·4	203·31			
·34	113·5		1·09151		201·75	202·17			
·42	114·7	8·09	1·23123	16,970	204·2	204·03	203·95	14,680	
·49	114·2		1·23123		204·0	203·84			
16·57	113·7	6·82	1·3680	19,260	211·5	211·35	209·01	15,040	
17·02	114·8		1·3680		205·75	205·80			
·09	114·1		1·3597		209·	210·11			

Tuesday 16th May

Set meter to work with plates of pure zinc cast from zinc obtained electrolytically by Mr Wiley. These had a brass wire cast into them. The top surface and the brass wire were three time coated with shellac varnish. The zinc plates were amalgamated twice. The analysis of the metal from which the zinc was cast (in my) showed no iron and less than 0.2 % of other metallic impurities. The solution was C.P. $ZnSO_4$ sp. g. 1.0574. The plates weighed as follow.

No.	Individual weight	Joint weight	No.	Individual weight	Joint weight
1	21.747	43.860	11	21.1768	43.2668
2	22.1135		12	22.0906	
3	22.101	43.698	13	21.4184	44.3531
4	21.598		14	22.9349	
5	21.203	42.877	15	22.5124	44.9578
6	21.5765		16	22.4460	
7	22.1244	44.3466	17	22.2092	44.1010
8	22.2224		18	21.8929	
9	21.507	43.8984	19	21.3635	43.2652
10	22.391		20	21.9017	

All the above ~~figures~~ quantities are observed and the agreement is very close throughout

The rubber screw head presses on nos 1 3 5 7 &c and the washer presses on nos 2 4 6 8 &c.

All the bottles had liquid in them to the same height approx.

These meters were set to work at 10.0 . 17. 5. 88 through 40 in.
at night they are set on the night cut thro 17.

log 4·8112 = 0·68225 = 7·933 94
·93881
·89513 78547

4·933 = 0·69311 = 7·84080
·93881
90199 7980

Wednesday 16th May

Pendulum observations

			T.		
1st series	10 complete vibs in	377·6 secs	T =	37·76
1st	5	" " "	188·8	"	= 37·76
2nd	5	" " "	188·8	"	= 37·76
2nd series	10	" " "	381·6	T =	38·16
1st	5	" " "	190·65		= 38·13
			190·95		= 38·19

Mean T = 37·96.

1st series $\left\{\begin{array}{l}\text{1st semicircle} = 452·25 \\ \text{2nd " " } = 94\end{array}\right\}$ $\lambda = \frac{1}{20}\log_e 4·8112 = 0·07855$
$1 + \frac{\lambda}{2} = 1·03927$

2nd $\left\{\begin{array}{l}\text{1st semicircle} = 446·0 \\ \text{2nd " " } = 93·25\end{array}\right\}$ $\lambda = \frac{1}{20}\log_e 4·7830 = 0·07980$
$1 + \frac{\lambda}{2} = 1·03990$

Mean $1 + \frac{\lambda}{2}$ = 1·03958 × mean T(37·96) = 39·462

Time	Volts	Ohms	Ind. C.	Amp. hours	1·5 ohm Tr. Error	Corrected Error	Mean	R (Sp. Error per Log-ohm)
8·58	0	–	0		2·2	2·2	2·27	161·1
10·03	0	–	0		2·2	2·2		
·11	0	–	0		2·2	2·2		
·39	114·0	14 L.	0·099	1905	9·	9·	9·29	657
·44	111·7		0·09975		11·4	11·4		
·51	113·3		0·09885		9·	9·		
·55	112·7		0·09885		7·75	7·75		
11·06	114·1	32 + 35 [illegible]	0·21	381	15·4	14·67	14·9	1057
·09	110·8		·19		13·	13·69		
·15	114·3		·197		16·1	16·35		
·24	112·2	12 + 49·5	0·395	762	27·3	27·65	28·31	2009
·42	114·8		0·415		29·7	28·63		
·48	113·5		0·400		28·65	28·65		
12·00	118·5	110·23 [illegible]	0·13609	1905	68·8	69·11	68·56	4865
13·10	114·0		0·13609		68·8	68·91		
·19	114·14		0·13758		68·60	67·66		
·27	113·6	72·93 [illegible]	11·35'	2857	96·3	96·33	96·04	6815
·31	113·2		11·30'		95·1	95·86		
·38	114·0		11·38'		95·9	95·93		
·45	112·7	54·11 [illegible]	15°15'	3810	120·25	120·58	121·87	8648
·50	111·9		14°55'		120.	123·15		
14·01	112·4	41·9 [illegible]	18°50	4762	?140·9	141·18	140·0	9935
·09	113·6		18°55		140·25	139·85		
·18	113·3		18°55		? 139·5	139·11		
·23	116·0	33·96 [illegible]	22°20	5715	157·1	156·81	157·58	11180
·28	113·6		22°30		156·75	159·16		
·34	113·5		22°25		157·7	156·76		
·48	112·2	24·74 [illegible]	28°20'	7620	172·25	174·65	171·68	12180
·54	112·2		28°40'		170·1	170·11		
·58	113·2		28°40'		172·8	170·29		
15·07	113·0	20·167 [illegible]	34°20'	9525	? 179·25	179·36	179·89	12770
·11	112·2		34°15'		179·1	179·10		
·16	112·5		34°10'		179·7	180·04		
·26	112·6	15·67	39°20'	11420	188·1	188·24	187·88	13330
·32	112·6		39°20'		? 186.	186·15		
·40	112·6		39°20'		188·25	188·40		
·47	110·2	12·55	43°45'	13335	190·1	189·98	191·4	13582
·58	112·6		44°0'		? 191·9	190·12		
16·03	112·9		43°40'		193	193·67		
·10	112·5	10·20	47°35'	15240	197·3	197·11	196·4	13940
·13	112·5		47°35'		196·44	196·23		
·17	112·5		47°35'		196	195·81		
·24	112·4	8·38 [illegible]	51°05'	17,145	202	200·62	200·23	14210
·31	112·2		50°55'		199·8	199·63		
·40	111·8		50°50'		200	200·43		
·49	111·5	6·73	53°35'	19,050	206·1	205·82	205·10	14580
·53	111·6		53°40'		203·25	204·32		
·57	111·4		53°45'		204·7	205·14		

Thursday 17th May.

10·30 Motor for a phonograph started by 10 cell Nitric Bichr battery.

Levelled the new Edison property.

Friday 18th May

Pendulum observations

T. 10 complete ibs in 409·47 sec $T = 40·947$

10 - - - 409·55 - $T = 40·955$

Mean $T = 40·951$

λ 1st swing $= 414·75$, 21st $= 66·25$ $\Big\}$ $\lambda = \frac{1}{20} \log_e \frac{414·75}{66·25} = 0·09022$

$1 + \frac{\lambda}{2} = 1·04511$

1st swing $= 402·75$, 21st $= 66·5$ $\Big\}$ $\lambda = 0·09086$ $1 + \frac{\lambda}{2} = 1·04500$

Mean $1 + \frac{\lambda}{2} = 1·04506 \times 40·951 = 42·796$

Day Constant $= n \times \frac{5·171 \times 10^{12} \times 42·796 \times 1·6 \times 10^{-16} \times 10^{-7}}{4·657 \times 10^{1}}$

$= n \times \frac{5·171 \times 4·2796 \times 1·6}{4·657} \times 10^{1}$

$D = 7·6031\, n \times 10^{1} = 76·031\, n.$

Took some preliminary photometric measurements as follows—

Compared our standard Carcel lamp with two Edison lamps that had been standardized at Newark and also with two standard candles.

1st Lamp 60" from Carcel flame.
marked 99½

Time	Current.		P.D. at lamp.		Res: in cent 130 volt ckt	Illumination		
	P.D. across	Check	P.D. across 1000	P.D. across lamp	Ohms	Carcels		
16·30	0·377		0·813	81·3	140ω	0·40		
·35	0·444		0·921	92·1	100ω	0·87		
·40	0·465		0·954	95·4	90ω	1·05		
·43	0·470		0·988	98·8	80ω	1·36		
·46	0·447		1·008	100·8	76ω	1·48		
·49	0·492		0·990	99·0	78ω	1·38		
·52	0·493		0·992	99·2	77ω	1·35		

2nd Lamp. marked 100½

·57	0·512		0·986	98·6	77	1·27		
17·00	0·517		0·992	99·2	75	1·29		
·2	0·524		1·003	100·3	73	1·39		
	Changed	simple	screw	for me	of paraffine	from wax	chop	
·10	0·520		1·00	100·	73	1·48		
·12	0·526		1·006	100·6	72	1·50		
1st	Lamp	again	with	paraffine	screw			
·15	0·502	0·098	1·008	100·8	75	1·58		
·18	0·498	0·097	1·00	100·	77	1·53		
·20	0·494	0·096	0·997	99·7	79	1·43		
·25	0·488		0·995	99·5	80	1·40		
·30	0·492		0·992	99·2	82	1·38		

2 standard Candles which burnt regularly were averaging at Carcel 5·8 during 701 seconds while they lost 40 grains. They should have lost 40 grains in 600 sec. ∴ that 1 Carcel = $\frac{5.8 \times 600}{701}$ = 5·82.
= 11·642 c.f. × 1·38 = 16·06 c.f.

$$a = \frac{d \times 0.7175 \times 10^{-7}}{154.75}$$

D.P.D. [illegible] 2 cms

$$b = a \times R$$

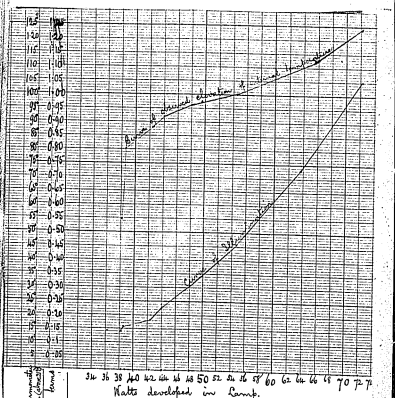
$$= \frac{d \times 0.7175 \times 10^{-7} \times 5170}{154.75} = d \, \frac{5.17 \times 7.175 \times 10^{-7}}{1.5475}$$

$$= \frac{d \times 2397}{46.57} = 51.47 d.$$

log 0.7175 = 7.85582
5170 = 3.71349
3.56931
3.857774
0.571557 0.571557×10^{2}

log 154.75 = 2.18963
46.57 = 1.66811
3.857774

Time	Volts	Ohms	Ind. C.	Ignition index	Throw	Corrected throw	Adjusted Mean Ignition	157 Amp Eq
10.20					2.3			
.35					2.0		2.1	108.2
.47					2.1			
11.06	116.2	42+	0.1	190.5	7.4	7.4		
.21	115.7	10.3	0.1		6.8	6.8	7.38	379
.27	115.6		0.1		6.75	6.75		
.36	115.2	2.2+473	0.2	381	12.5	12.5		
.40	115.0		0.2		13.1	12.1	12.97	668
.45	115.0		0.2		13.3	13.3		
.51	115.0	1.2+656	0.4	762	23.7	23.7		
.56	114.9		0.349		23.8	23.85	23.83	1227
12.01	114.4		0.325		23.9	23.95		
13.17	114.2	110.23	0.18689	1905	57.90 [illegible]	58.03		
.23	114.3		0.13656		57.8	57.93	57.93	2982
.27	114.3		0.13656		57.8	57.93		
.35	114.7	73.46	0.202497	2887	84	84		
.39	114.7		0.202497		82.4	82.4	83.4	4293
.44	115.0		0.202497		82.8	83.5		
.53	114.3	53.27	0.273224	3810	106.9	106.94		
14.00	114.4		0.273224		107	107.04	106.9	5502
.09	114.5		0.274019		107	106.68		
.19	112.0	42.35	0.337783	4762	127.9	128.37		
.24	112.4		0.344270		124.75	125.39	126.2	6496
.32	112.4		0.344270		125.3	124.94		
.45	114.1	34.81	0.409911	5715	140.8	140.73		
.50	114.3		0.410891		139.3	139.05	140.3	7273
.55	114.4		0.411871		140.1	140.95		
15.02	113.7	25.69	0.524.60	7620	159.4	159.05		
.14	114.0		0.524.62		159.75	158.21	160.35	8253
.19	112.7		0.531171		159.4	162.88		
.30	113.8	20.365	0.68307	9525	169.1	161.1		
.37	113.6		0.683.71		168.4	161.14	168.3	8662
.41	112.4		0.685146		165.7	163.3		
16.08	112.2	18.057	0.819246	11420	216.8	164.93		
.15	111.0		0.824.90		171.7	171.33	170.68	8770
.19	111.2		0.824.90		171.1	170.73		
.24	109.2	13.85	0.96898	13335	176.0	176.44		
.28	113.2		0.95753		176.5	175.74	177.37	9131
.32	113.9		0.95751		179.5	178.42		
.42	113.2	10.49	1.09450	15240	184.1	185.02		
.46	113.3		1.09131		184.8	185.17	186.25	9589
.49	112.9		1.09131		187.3	187.67		
.54	118.9	8.71	1.22638	17115	191	192.28		
.57	113.0		1.22758		189.8	190.20	191.98	9972
17.05	112.5	7.11	1.36800	19.050	195.1	194.94		
.09	112.4		1.36800		193.4	193.34	193.70	9970
.14	112.3		1.36813		192.1	192.94		



Saturday 19th May.

Made following measurements of illumination and temperature of an Edison lamp.

The 99½ volt lamp tested on the previous day was employed as the standard of light and its voltage was maintained constant during the experiment with the aid of a rev. box and an A.M. voltmeter.

The lamp under test is an ordinary 16 cp lamp with a Fahr. thermometer enclosed in the vacuum. The photometer chamber in which it rested was 53 ins wide 63 ins (back to front width) and 73 high. The thermometer in the lamp gives 212° high. The thermometer in the lamp gives 212° high. The thermometer was standard by its side at 15°C.

Time	P.D. across the lamp	C.	Observed C.	CP	P.D. across lamp per cp	Res.	Int. Temp	Ex Cl. Temp in Room	Cs. by Observed Current and P.D.	Energy in lamp in watts
11.09	0.500	0.5015	0.101	0.11445	0.710	170.	70.5°	22.5°		38.11
" 14	0.504	0.5055	0.107	0.1587	0.762		101.1	23.5	0.592	38.62
" 23	0.530	0.5316	0.106	0.1818	0.795		109°	24.9	0.626	42.26
" 34	0.544	0.5456	0.107	0.2299	0.807		118°	25.	0.531	48.90
" 37	0.570	0.5717	0.114	0.3077	0.840		117.	25.5	0.566	48.02
" 39	0.612	0.6138	0.123	0.4546	0.890		121°	26.	0.611	54.63
" 42	0.670	0.6720	0.134	0.730	0.950		133°	24.5	0.665	63.84
" 46	0.719	0.7211	0.144	1.05	1.000		145°	24.5°	0.715	72.11

Several throws and series of λ were obtained with the ballistic Galv. as follows:—

1 Batt. all 1.1455 volts through 0.5 ϕ = 154.25 v 0.5
155.75 T. 0.85
153.90 0.85
2 × 155.70 −1.35
309.60 2.70

$= .7175 \times 10^{-7}$ a.

T =

Mean. 154.75 ± 0.33

$\frac{0.6453 \times 2.7}{4 \times 1.722} = 0.324$

Monday 21st May.

Made following determination of position of cross in Edison pressure wire system.

Res: of lines from Bridge to E.R. + and − only, the neutral being faulty — 0.7114

Res: of these lines + + and − mains — 0.9606 − 0.7114 = 0.2542

−	+	+	−	0	1.1593 = 0.4479
−	+	−	−	0	1.1595 = 0.4481

From which Res. of + Main = 0.1270

− − − = 0.1272

− − 0 − = 0.3209

Added Res. in Varley Balance

to neg. lead main 1000/1000 0.2w = 0.4797ω from bridge

1000/100 8.337 = 0.4780 − −

1000/10 67.6 = 0.4787 − −

The res: of the neg: lead to E.R. is supposed to be 0.7114 ÷ 2 = 0.3557 including battle wires.

0.4787 − 0.3557 = 0.1230 ω from end of tube

0.1272 − 0.1230 = 0.0042 ω from catch box in neg. main

$0.0042 \div 0.00007.15 = 42 \times 10^{-4} \div 7.15 \times 10^{-5}$

= 60 feet from catchbox.

Res: of contact was about 120ω

The result of the 14th May page 46 was 0.0249 for end of neg. main.

On examining connection in Engine Room found mains connected by two groups of 5 lamp heads in the Engine room, so that assuming the res: of a lamp at 400ω this would be 80ω between + 0 also 80ω between − and zero. Removed these and tested again.

Made + 0 Main	0.1270	Res: of contact now	130,000ω
− −	0.1282	Ins: of pressure wire	3,600ω
0 −	0.3242	No reliable balance obtainable.	

Insulation of the whole Edison system jump up about 3000ω

T' during 2·5 cm. Interpolar Dist.

Throws from 1 Bl. Rho: 0·5 t = ·7176 microvoltsmtr.

1st	L	131	−0·25
2nd	R.	132·5	+ 1·75
3rd		134	+ 3·25
4th	L	125·5	−5·25
		3·0	10·5 = 2v

Mean 130·75 ± 1·3

$\frac{0.848 \times 10.5}{4 \times 1.73} = 1.3$

$$a = \frac{d \times \cdot 7176 \times 10^{-7}}{130.75}$$

$$\mathfrak{L} = \frac{d \times 0.7176 \times 10^{-7} \times 5.190 \times 10^{3}}{130.75 \times 46.657} = \frac{7.176 \times 5.190 \times 10^{1}}{1.3075 \times 46.657}$$

$= 61.16.$

log ·7176 = ·85588
5·190 = ·71517
57105

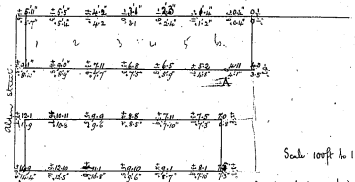
log 130·75 = ·116444
46·57 = ·66811
78455

78455
78455 = 61.16

Time	Volts	Ohms	Ind. B.	Phase	Corrected	Adjusted Mean	Induction Constant per L	60
18·05	115·4	324·270	0·1	5	5			
·20	115·4	-	0·1	4·8	4·8			
·35	114·9	-	0·1	?5·75	5·75	5·2	318	
·49	115·5		0·10095	5·5	5·5			
·28	115·7	12 + 324	0·2	10·3	10·3			
·38	115·1	-	0·10095	10·0	10·0	10·16	621	
·39	115·0	-	0·2	? 10·2	10·2			
·47	114·5	12·67	0·4	18·0	18·0			
·51	116·0		0·40095	18·0	18·0			
·55	118·3		0·4	16·8	16·8	18·20	1113	
·59	114·7	-	0·4	18·0	18·0			
13·14	113·9	110·23	0·13669	46·6	46·6			
·23	113·7		0·13669	46·9	46·9	46·8	2863	
·29	114·2		0·13768	47·1	46·8			
·43	114·7	73·32	0·20497	65·75	65·75			
·48	114·2		0·20497	64·6	64·15	64·66	3955	
·55	114·5		0·20497	64·1	64·1			
14·05	112·2	55·92	0·27419	80·5	80·25			
·10	115·2		0·27419	? 82·9	82·65	81·25	4970	
·20	114·0		0·27419	81·8	81·55			
·24	113·4	43·95	0·32101	97·5	97·70			
·32	114·9		0·32101	97	97·20	97·5	5960	
15·15	111·9		0·33753	96·5	97·61			
·25	113·6	38·57	0·41013	111·1	111·1			
·29	112·4		0·40911	111·7	111·86	111·3	6808	
·43	113·8		0·41051	111·1	110·9			
·51	113·5	26·55	0·52473	127·25	127·25			
·54	113·4		0·52462	128·9	127·35	127·42	7792	
·58	111·8		0·52462	126·9	127·34			
16·05	113·5	21·12	0·61301	136·7	136·1			
·09	113·7		0·61301	135·25	135·25	135·7	8300	
·16	112·3		0·62495	140·2	142·04			
·23	114·2		0·63169	144·275	142·76	144·6	8861	
·30	109·2	13·95	0·92439	146	147·12			
·34	113·2		0·93729	147·1	147·02	149·07	9120	
·40	112·8	11·365	1·09770	150	149·4			
·43	112·7	11·463	1·09131	150·5	150·8	150·1	9181	
·51	112·5	9·249	1·23986	153·1	152·06			
·58	112·7		1·2239	153·6	152·39	153·2	9370	
17·03	114·4	7·58	1·34019	157·75	158·81			
·08	109·9	7·58	1·3151	155·	161·10	157·58	9640	
·12	111·2		1·3297	157·	157·83			

Tuesday 22nd May

Levelled at the Edison Phonograph property as follows:—



Scale 100ft to 1".

The black ink figures are the level taken by ourselves. The red ink figures are those by the surveyor reduced from decimals of a foot to feet & inches. The red ink figures running across the line are those marked on the stakes as level above and below the Stake A

5 Lalande cells were set up at noon on the 19th May. as follows. with flake oxide of Copper

No.	Chemicals	P.D.	E.M.F	C.	I.R.
22	20% NH_4Cl	0·203	0·223	0·609	0·032 ? Polarising
23	20% KHO	0·610	0·955	1·830	0·018
24	20% KHO	0·506	0·542	1·518	0·023
25	20% KHO	0·574	0·943	1·722	0·021
26	20% KHO	0·590	0·948	1·770	0·020

Lalande cells.

No.	Time	Hours for start	Solution	Peroxide	P.D.	EMF	Q	S.R.
22	15.30	75 hours	NH_4Cl	flake	0.162	0.234	0.496	0.148
23		"	KHO	"	0.500	0.590	1.500	0.060
24		"	Removed		0			
25		"	KHO	"	0.514	0.604	1.542	0.058
26		"	KHO	"	0.492	0.670	1.476	0.120
27		0	NH_4Cl	powder	0.300	0.354	0.900	0.060
28		"	"	"	0.450	0.508	1.350	0.042
29		"	"	"	0.544	0.565	1.632	0.012
30		"	"	flake	0.470	0.514	1.410	0.031
31		"	"	"	0.544	0.594	1.632	0.030
32		"	"	"	0.568	0.610	1.704	0.030
19.10	18.00							
23		11½	KHO	flake	0.490	0.580	1.470	0.061
25		"	"	"	0.510	0.616	1.530	0.069
26		"	"	"	0.482	0.580	1.446	0.067
27		2½	NH_4Cl	powder	0.294	0.350	0.882	0.063
28		2½	"	"	0.384	0.446	1.152	0.053
29		"	"	"	0.504	0.538	1.512	0.022
30		"	"	flake	0.430	0.466	1.290	0.027
31		"	"	"	0.470	0.550	1.410	0.056
32		"	"	"	0.522	0.558	1.566	0.022
23.10.15	8.00							
23		9½	KHO	flake	0.382	0.464	1.146	0.071
25			"	"	0.400	0.490	1.200	0.076
26			"	"	0.381	0.460	1.143	0.069
27		16½	NH_4Cl	powder	0.260	0.350	0.880	0.102
28				"	0.228	0.290	0.684	0.090
29					0.464	0.504	1.392	0.040
30				flake	0.288	0.330	0.864	0.048
31				"	0.400	0.474	1.200	0.061
32				"	0.478	0.522	1.434	0.030

T.C. 15·6c. Pendulum swing T. L P. D. 3 cm.

EMF 1·4373

Disch. from 1 C.C. 0·5t

131	L X2 =	262	= 0·65
131·9	R X2 =	263·8	= 1·62
132·1	R X2 =	264·2	= 2·52
? 130·1	L X1 =	130·1	= 1·24
131·0	R X2 =	262	= 0·68
		4 | 1132·1	5·5·24
	Mean.	131·34	± 0·37

Disch. from 1. C.C. 0·5t

130·5	−0·25
130·25	+0·05
130·0	+0·25
130·25	0·05

EMF 1·4358 = 130·25 ± 0·1

$$\mathcal{L} = \frac{d \times 0{\cdot}71828 \times 51{\cdot}64}{130{\cdot}795 \times 46{\cdot}57} = 60{\cdot}895.$$

Time	Volts	Ohms	Ind. C.	Amp. turns	Thickness	Corrected	Mean	Lines per cm.
10·17	-	-			1·78	1·78		
·24	-	-			1·90	1·90	1·78	108.
·27					1·7	1·7		
·36	101·5	22+260	0·1	190·5	4·5	4·5		
·47	100·2		0·1005		4·8	4·78	4·64	232·6
·53	101·2		0·099		4·5	4·54		
11·09	102·7	12+300	0·205	391	9·4	9·17		
·16	102·0		0·20		8·75	8·76	8·98	546·8
·26	103·5		0·20		9·0	9·0		
·33	106·5	12+352	0·140	762	17·3	17·3		
·39	106·5		0·140		17·5	17·5	17·4	1059·5
·52	103·7		0·140		17·4	17·4		
·40	108·5	117·5	0·13261	1905	40·1	40·72		
·48	102·7		0·13313		40·8	41·19	41·4	2521
·54	103·3	116·5	0·13609		41·4	41·52		
·59	103·2	116	0·13669		41·4	41·44		
13·29	109·7	75·405	0·20497	2598	? 62·8	62·83		
·36	111·2		"		59·0	59·03		
·33	110·5		"		58·3	58·32	59·62	2631
·42	111·7		"		58·9	58·92		
·51	109·1	55·06	0·27263	~~1762~~ 3810	73·2	73·40		
·57	109·7		"		73·1	73·31	73·48	1447·5
14·04	109·2	-	"		? 73·8	74·00		
·14	109·0	43·24	0·34270	~~5744~~ 10762	87·0	86·75	"	
·19	109·6	-	0·34140		89·9	89·98		
·23	109·4	-	0·34183		86·4	86·37	88·37	5211
·29	110·5	-	0·34108	9	81·2	81·27		
·33	110·2	-	0·34270		88·2	88·26		
·45	110·2	35·31	0·40911	~~7600~~ 15715	95·5	95·48		
·52	111·2		0·40911		100·8	102·3	101·04	6153
·58	111·7		0·40911		102·6	102·9		
15·07	111·6		0·40761		102·3	102·06		
·21	111·5	22·06	0·52633	~~9525~~ 7620	121·5	~~122·36~~ 120·40	1208	7356
·27	111·5		0·52672		121·1			
·31	111·3		0·52673		120·1			
·40	111·5	19·75	0·68088	9525	128·9	129·36		
·44	111·4	-	0·68301		? 129·5	129·55	129·69	7897
·52	112·0	-	0·68311		130	130·07		
·59	111·9	16·62	0·81946	11430	135	135·1		
16·07	111·1	-	0·81946		135·5	135·6	135·35	8242
·17	112·5	13·49	0·95729	13335	140·8	140·7		
·21	112·7	-	0·95729		140·3	140·2	140·57	8560
·26	113·0		0·95729		140·9	140·8		
·39	113·3	11·08	1·09125	15240	143·4	143·3	143·08	8714
·46	113·2	-	1·0977		144·25	142·85		
·52	113·5	9·25	1·2223	17145	146·9	148·1	147·79	9000
·57	113·9		1·2229		146·7	147·45		
17·03	112·5	7·80	1·3680	19050	148·9	148·78		
·07	113·2	-	1·3698		? 148·85	149·19	149·27	9029
·12	112·2		1·3814		? 148·0	148·92		

22.5.88 | Interpolar Dist 3·5 cm. Swing 7°

1 B.B. 0·5 f E.M.F. 1·4253 = 0·7177 coulomb, ×10⁻⁶

131	−0·25
132·5	−1·75
134	−3·25
135·5	+5·25
3·0	10·5

Mean 130·75 ± 1·3

$$\frac{0.84253 \times 10^{-5}}{4 \times 1.73} = 1.28$$

17. orbit

131·5 × 2 = 263·0
132·1 × 2 = 264·2
132·7 × 1 = 132·7
132·2 × 2 = 264·4
7924·3
132·04

132·04
130·75
262·79
131·4

$$\mathcal{L} = \frac{\text{dt} \times 0.7177 \times 5225}{131.4 \times 46.57} = \frac{37499825}{6119298} = 61.281$$

log 7·177 = 8559 44
5225 = 718 09
5740 3
7867 1
79732 = 6129

log 131·4 = 11860
46·57 = 66811
78671

Time	Volts	Ohms.	Ind. B.	Amperes	Phase	Corrected	Mean	$\mathcal{L}$	Volts
10·06	115·5	32+268	0·1	190·5	3·2	3·2			
·10	113·7		0·10		3·3	3·3	3·29	202	
·16	114·2		0·1095		3·26	3·38			
·25	115·4	12+312	0·20	381	7·25	7·25			
·30	115·2		0·2		? 8·14	? 8·14			
·38	114·6		0·2		7·24	7·2	7·46	457	
·46	114·6	12+65	0·2	762	14·7	14·7			
·52	115·[illegible]		0·2		15·5	15·5	15·4	944	
·59	114·4		0·2		15·9	15·9			
11·11	113·5	133·23	0·13469	190·5	39	39			
·15	112·1		0·13469		39	39	39·0	2390	
·24	113·9		0·13469		39	39			
·39	114·4	73·02	0·20447	2817	56·3	56·31			
·44	114·2		0·20447		57	57·01			
·48	114·8		0·20449		? 57·6	? 57·19	56·77	3480	
·57	113·2	54·11	0·27263	3810	71·1	71·29			
12·18	113·2		0·27263		71·3	71·49	71·56	4390	
·21	113·0		0·27263		71·7	71·89			
·31	113·9	44·08	0·33265	4762	83·1	83·65			
·41	113·5		0·33105		84·2	84·36	84·26	5760	
·48	113·5	43·29	0·33105		? 85	? 85·16			
·55	113·2	35·31	0·40051	5715	98·9	98·72			
13·09	113·3	[illegible]	0·40051		98·1	97·92	97·85	5996	
·16	113·0		0·40911		96·7	96·92			
·15	112·7	26·06	0·54673	7620	113	113			
·19	113·3		0·54673		113·9	113·9			
·21	112·7		0·54673		? 114·75	? 114·75	114·72	7020	
·24	113·3		0·54673		115	115·0			
·31	111·4	19·85	0·67401	9525	123	124·62			
·38	112·1		0·68301		123·5	123·37	124·22	7610	
·43	112·3	24·95	0·68301		124·4	124·47			
·53	112·3	16·72	0·82423	11430	? 130	128·87			
·59	112·2		0·82423		129	127·77	127·94	7840	
15·04	112·3		0·82423		127·1	127·67			
·11	112·2	13·75	0·95621	13395	134·8	135·12			
·14	112·6		0·95621		134·7	135·02	135·07	8280	
·22	112·4	11·37	1·07145	15240	139	138·87			
·25	112·4		1·07145		138·2	138·07	138·47	8490	
·31	111·0	9·25	1·2276	17145	142·8	142·10			
·34	111·3		1·2276		143·7	142·00	142·55	8500	
·40	112·5	7·99	1·3680	19050	? 144·6	144·49			
·42	112·1		1·3638		144·7	145·02	144·36	8852	
·44	111·6		1·3680		? 143·7	145·57			

Leclanché cells

No.	Date	Time	Hours at work	P.D.	E.M.F.	C.	I.R.	Solution	Oxide
23	May 23	17.	100	0.392	0.455	1.176	0.053	30% KHO	flake
25			100	0.400	0.472	1.200	0.060	30% KHO	"
26			100	0.370	0.446	1.110	0.068	30% KHO	
27			~~100~~ 25	0.258	0.356	0.774	0.113	NH_4Cl	powder
28			25	0.214	0.278	0.642	0.099	NH_4Cl	"
29			25	0.446	0.488	1.338	0.031	NH_4Cl	"
30			25	0.200	0.232	0.600	0.053	NH_4Cl	flake
31			25	0.375	0.460	1.125	0.075	NH_4Cl	"
32			25	0.444	0.494	1.332	0.038	NH_4Cl	"
23	May 24	8.	115	0.302	0.336	0.906	0.031	30% KHO	flake
25			"	0.302	0.370	0.906	0.075	30% "	"
26			"	0.056	0.062	0.168	0.030	30% "	" Removed
27			40	0.244	0.340	0.732	0.131	NH_4Cl	powder
28			"	0.256	0.350	0.768	0.122	"	"
29			"	0.408	0.450	1.224	0.034	"	"
30			"	0.120	0.158	0.390	0.071	"	flake
31			"	0.258	0.364	0.774	0.108	"	"
32			"	0.306	0.358	0.918	0.045	"	"
33	May 24	16	0	0.852	0.612	1.656	0.086	20% Leclanché	powder
34			0	0.578	0.724	1.554	0.123	15% NH_4Cl	"
35			0	0.578	0.623	1.554	0.067	10% NH_4Cl	"
36			0	0.744	0.702	1.332	0.193	5% NH_4Cl	"
23	May 24	17	124	0.096	0.226	0.198	0.607	removed	
25			"	0.0	0.0	"	"		
27			149	0.224	0.300	0.672	0.111	NH_4Cl	powder
28			"	0.254	0.368	0.762	0.111	NH_4Cl	"
29			"	0.374	0.422	1.122	0.042	NH_4Cl	"
31			"	0.200	0.274	0.600	0.123	NH_4Cl	flake
32			"	0.187	0.210	0.561	0.040	NH_4Cl	flake
33			"	0.562	0.580	1.506	0.051	20% NaCl	powder
34			"	0.532	0.584	1.596	0.046	15% "	"
35			"	0.503	0.567	1.509	0.042	10% "	"
36			"	0.468	0.568	1.404	0.071	5% "	"

Interplay Dist. 4 cones. T swing. 24th May 1888

Res. of Magnet 5.35 − 0.578 = 4.772
" Circuit 3.52 − 0.365 = 3.155

Disch. Standard cell 1.434 volts = 0.717 "

133.8
134.4
133.3
133.8
133.8

After Reading had been taken.

136.75
135.5
135.6
134.8
134.9
26.55
13.5.3

135.3
133.8 } 134.55 Mean

$$\mathcal{L} = \frac{dx \times 0.7177 \times 5225}{134.55 \times 46.57} = \frac{37\,5000}{6266} = 59.85$$

Time	Volts	Ohms	Ind. C.	Throw	Throw	Throw	Corrected	Mean	$\mathcal{L}$
9.45	113.4	2C+225	0.1	190.5	3.3	3.2			
·57	113.2				3.2	3.2		3.23	205
10.07	113.6				3.8	3.8			
·17	113.3	1C+290	0.2	381	7.6	7.60			
·25	112.2		0.2008		7.25	7.25		7.57	453
·29	114.2		0.2005		7.9	7.88			
·39	113.3	1C+682	0.397	762	16.6	16.71			
·45	112.4	"	0.4110		14.7	14.34		14.29	855
·52	112.2	" +623	0.405		14.	13.83			
11.11	113.4	103.6	0.13669	1905	37.9	37.9			
·16	114.6	"	0.13669		37.7	37.7		37.73	2256
·19	113.8	"	0.13669		37.6	37.6			
·36	113.1	73.1	0.20457	2857	56.6	56.6			
·40	113.0	"	0.20457		52.4	52.4		52.0	3112
·45	112.5	"	0.20457		52.	52.0			
·57	112.3	55.5	0.27127	3810	65.5	66.06			
12.16	113.2	54.8	0.27326		66.5	66.50		66.32	3968
·21	112.4	54.8	0.27326		66.4	66.40			
·33	112.2	42.9	0.34108	4762	80.0	80.0			
·41	114.8	"	0.34270		80.5	80.27		80.42	4812
·44	113.4	"	0.34108		81.0	81.0			
·59	114.0	35.5	0.40911	5715	92.1	92.31			
13.07	113.1	"	0.40911		91.5	92.10		92.21	5518
·15	112.5	"	0.40911		92.0	92.21			
·29	113.5	24.3	0.52673	7620	109.9	109.9			
·35	112.7	24.3	0.52673		109.8	109.8		109.60	6560
·41	114.2	"	0.52762		109.9	109.5			
·55	112.4	20.95	0.68088	9525	119.2	119.64			
15.05	113.7	"	0.68728		119.8	119.13		119.26	7140
·15	112.4	"	0.68301		119.	119.0			
·24	113.3	16.72	0.82434	11430	125	124.34			
·30	113.1	"	0.82190		124.4	124.13		124.67	7463
·37	113.2	"	0.82190		125.8	125.83			
·44	113.0	12.83	0.97729	13335	129	128.83			
·57	113.5	"	0.97729		130.1	130.03		129.76	7769
·55	113.2	"	0.97729		130.4	130.33			
16.07	113.2	11.27	1.09148	15240	134.6	134.48			
·13	113.3	"	1.6913		133.2	133.46		134.17	8032
·20	113.2	11.07	1.6918		? 134.7	? 136.16			
·29	112.9	"	1.09148		133.7	133.58			
·46	112.4	8.76	1.3386	17145	? 137.3	? 137.36			
·57	113.2	"	1.3386		137.9	138.96		137.34	8217
17.55	113.3	8.86	1.2276		? 137.5	? 138.09			
17.02	112.2	7.21	1.3764	19050	140.	139.03			
·06	112.4	"	1.3722		140.	139.46		139.32	8337
·12	112.7	"	1.3722		140.	139.46			

Thursday. 22k May.

The energy developed by a Lalande 30% Lewis potash cell = 204,000 Joules at supply of 1.15 Volts by the curve of March 88.
and 660,000 Joules at supply of 1.05 Volts by the standard curve of Apr: 88.
The mean may be taken as 650,000 Joules.
Cell no 29 of saturated NaOH gave 98,000 Joules at supply of 0.678 for 40 hours.
also 140,000 Joules
at supply of 0.68 for 64 -
The corresponding values for Lewis Potash 30% = 199,000
and 288,000

Saturday 26k May.

Edison house system testing as follows.

Insulation of + main (houses off)	1300 ω
- - - (- -)	12,000 ω
- - 0 - - -	200,000 ω
Insulation of all 3	1,150 varying
Archenclos' house joined up Insulation	1,150 ω Lamp
Res: between + and 0.	190 ω Lyl
- - - 0	11,000 ω
Burke's house joined up also Insulation	1,125 ω.
Res: between + and 0.	100 ω Lyl
- - - 0	11,000 ω
Edison's house joined up also Insulation	1,050 ω Lamp
Res: between + and 0.	7.5 ω 46
Res: - - - 0	70 ω 5

Res: of standard Clark cells about 75 ω each

Weight of Hematite - paraffin core 550 grammes.

1st set $\begin{cases} 1^{st} \text{ semiint } 4.08 \\ 2^{nd} \quad - \quad 83.3 \end{cases}$ $\lambda = \frac{1}{20} \log_e \frac{4.08}{83.3}$

2nd set $\begin{cases} 1^{st} \quad - \quad 483.75 \\ 2^{nd} \quad - \quad 97.5 \end{cases}$ $\lambda = \frac{1}{20} \log_e \frac{483.75}{97.5}$

3rd set $\begin{cases} 1^{st} \quad - \quad 483.75 \\ 2^{nd} \quad - \quad 89.75 \end{cases}$ $\lambda = \frac{1}{20} \log_e \frac{483.75}{89.75}$

$$\frac{H}{G} \frac{T}{\pi} \sin \frac{\theta}{2} \left(1 + \frac{\lambda}{2}\right) = E K$$

where $\frac{H}{G} = \frac{C}{\tan \theta_1} = \frac{E}{R \tan \theta_1}$

$$\therefore K = \frac{T \left(1 + \frac{\lambda}{2}\right) \theta}{2 \pi R \theta_1}$$

The following measurements were taken with a view to determining the accuracy of our measurements with the pendulum using inductometer.

λ and T were first determined as follows.

1st series 10 complete vibs in 374.93 sec T = 37.493
2nd - - - - - 375.50 - T = 37.550
3rd - - - - - 375.71 - T = 37.571

Giving to the first ½ the weight of the second and third, we have

0.493
1.000
1.142
2.735 ÷ 5 = 37.547

In 1st series λ = 1.03977
- 2nd - λ = 1.04004
- 3rd - λ = 1.04045

Giving to the first ½ the weight of the second and third, we have $-23 + 8 + 90 = 75 \div 5 = 15$

= 1.04015

The throws from a standard cell 15.0°C (1.4342 volts) and the Elliott .5 ϕ =

136.25
136.8
137.9
136.4

ϕ Mean 136.8 ± 0.25

The same cell in circuit with a high res: of carbon gave deflections.

R 334
L 326
R 323.5
L 315.5 best. θ_1

Best = 315.5 but possible error of ± 5.0

The high res: was measured at 5.4×10^{15} but possible error of 0.1 ±

From these values

$$K = \frac{T(1+\frac{1}{3})\theta}{2\pi R\ \theta_1}$$

$T(1+\frac{1}{3}) = 37.547 \times 1.04015 = 39.055$

$T(1+\frac{1}{3})\theta = 5314.2657$

$2\pi = 6.28318$

$\frac{T(1+\frac{1}{3})\theta}{2\pi}$ 845.03101

Taking $R = 5.4 \times 10^{15} + \theta_1 = 315.5$ $R\theta = 17.037 \times 10^{15}$

or $K = 0.16990 \times 10^{15}$ Best result

Taking $R = 5.3$ and $\theta = 310.5$ $R\theta = 16.457 \times 10^{15}$

and $K = 0.5167 \times 10^{15}$ Max. Possible result

Taking $R = 5.5$ and $\theta = 320.5$ $R\theta = 17.6275 \times 10^{15}$

and $K = 0.4824 \times 10^{15}$ Min. Possible result.

The capacity is therefore correct to 0.2% by the accepted figs: and is certainly within 1.5% of truth.

Lalands cells

No.	Date	Time	Hours at work	P.D.	EMF	C.	I.R.	Solution
27	25.5.	8.	64	× 0.198	0.312	0.594	0.191	NaOH + powder
28				0.226	0.374	0.678	0.218	– –
29				0.328	0.380	0.984	0.052	– –
31				× 0.155	0.236	0.465	0.074	– flake
33			16	0.476	0.542	1.428	0.039	20% NaOH
34				0.397	0.444	1.191	0.047	15% – –
35				0.472	0.556	1.416	0.039	10% – –
36				0.338	0.498	1.014	0.157	5% – –
28	25.5.	17.	73	0.215	0.374	0.645	0.242	NaOH powder
29				0.314	0.366	0.942	0.055	– –
33			25	0.364	0.543	1.092	0.163	20% NaOH –
34				0.346	0.424	1.098	0.052	15% – –
35				0.419	0.500	1.257	0.064	10% – –
36				0.302	0.466	0.906	0.181	5% – –
28	26.5	8	88	× 0.185	0.354	0.555	0.124	NaOH powder
29				0.264	0.316	0.792	0.065	– –
33				0.406	0.512	1.218	0.037	20% NaOH
34				0.210	0.276	0.630	0.045	15% –
35				0.316	0.466	0.948	0.157	10% –
36				0.263	0.414	0.789	0.226	5% – –
29	26.5.	16	81	0.250	0.296	c		
33				0.408	0.570			
34				0.140	0.200			
35				0.392	0.485			
36				0.283	0.420			

Monday 28th May.

If 1 H.P. cost $60 per ann. what will be the cost of evolving Chlorine gas from NaCl by Electrolysis?

Using Carbon electrode Cl will appear at the anode and Sodium at the cathode, which in turn will be converted into Soda evolving hydrogen from the water.

The g. Calories evolved by the union of two equivalent of hydrogen and Chlorine appears from Wiedemann's book to be 17,400 so that the E.M.F. would be $\frac{17,400 \times 4.2}{79,3000}$ = 0.8 volt approx.

~~Thus in Jordin~~

10 amperes in one sec. decompose 0.00363 grm. of Cl.

and at 0.8 volt pressure one H.P. = 932 amperes

so that the decomposition is 932 × 0.00363 grm.

for 1 H.P. per sec. = 0.388 grm.

1 H.P. hour = 0.388 × 3600

= 1218 grm.

= 23,1500 lbs per ann. ~~[illegible]~~ = 2.68 lbs. per hour

Tried a couple of carbon sticks in a solution of salt and water. The res. was found to be 625ω with true zero and about 40ω to false zero with approx. the same current 0.05 amperes.

or E.M.F. of polarization = 0.005 (625 − 40)

= 0.005 (585) = 1.7 volts.

Repeated test with greater care

Res. 0.004 amperes + t.z. 810 − 150 = 660

" 0.004 " f.z. 400

EMF of polarization 620 × 0.004 = 2.48 volts.

Placed the rod in HCl dilute.

Res. t.z. 0.005 = 400 − 15 = 385 } 360 × 0.005 EMF 1.8 volts

" f.z. " = 40 − 15 = 25

Sent current of about 1·5 ampères through cell of HCl with carbon electrodes and turned the circuit quickly over from the 100 volt mains to the Potentiometer. The P.D. was about 1·63 volts falling quickly. The same electrodes in NaCl. 2·56 volts

---

The no: of ampères from a HP. @ 2·56 volt = 291
1 Ampère will liberate ~~[illegible]~~ 0·000367 grs per sec
or $3600 \times \cdot 000367$ grs per hour.
$3.6 \times 10^3 \times 3.6 \times 10^{-4} = 1.321$ grs. per hour.
1 HP ∴ gives. $291 \times 10^3 \times 1.321 = 384.4$ grs per hr
$= \frac{384.4}{454} = 0.847$ lbs. ∴

The no. of ampères from a HP @ 1·75 volts = 426
1 HP. $426 \times 1.321 = 562.7$ grs. per hour
$= \frac{562.7}{454} = 1.24$ lbs ∴

In a year there are about $360 \times 24 = 86400$ hours.
If a HP per ann. cost d dollars.
the price of 1 HP. hour $= \frac{d}{86400}$.
and for this sum p pounds being evolved
∴ 1 pound will cost $\frac{d}{86400p}$

Assuming d at 60 Mr Edison's estimate
for NaCl p = 0.85 and price per lb $= \frac{60}{73,440} = \frac{1}{1220}$
$\frac{1}{12}$K of a cent.

---

for HCl p = 1·24 and the price $= \frac{60}{107,000} = \frac{1}{1800}$.
$\frac{1}{18}$K of a cent.

One ampère will deposit 0·0003367 grs. of Zinc per sec = 0·0020202 grs. per min:
= 0·121212 - - hour.
= 0·00267 lbs. - -
or 1 lb. of zinc in 1 hour by 374 ampères.

As an experimental fact 3 ampères deposited 1½ oz = 0·0938 lbs. in 1½ hours from Zinc solution
at rate of 0·0469 .. . .
- - - 0·00335 - - 1 hour.

Data connected with the heating of a wire by a steady current

Let ρ be the spec: res: of the conductor
d . its diameter
c . the traversing current in abs: units.
Then its area will be $\frac{\pi d^2}{4}$
and its res: per unit length $\frac{4\rho}{\pi d^2}$
The energy liberated by the current per unit of length is thus $\frac{4c^2\rho}{\pi d^2}$ ergs per sec:
and as 1 gram calorie is $4{\cdot}2 \times 10^7$ ergs or J
this represents an accession of heat per cm per sec.

$$\frac{4c^2\rho}{J\pi d^2}$$

The specific heat of the metal being s and its mass being $\frac{\pi \delta d^2}{4}$ per unit length; δ its density
the heat consumed in raising its temp. 1°C
$= \frac{\pi s \delta d^2}{4}$ or through t°C $= \frac{\pi s \delta d^2 t}{4}$
and if no heat were lost by the wire t would rise continually for after n seconds

$$\pi s \delta d^2 t \text{ would} = \frac{16c^2\rho n}{J\pi d^2}$$

$$\text{or } t = \frac{16c^2\rho n}{J\pi^2 d^4 s \delta}$$

so that its temp: would increase by $\frac{16c^2\rho}{J\pi^2 d^4 s\delta}$ °C per sec:

But t increases more and more slowly until the Radiation R and convection V which represent the loss of heat per sec: equate the accession of heat per sec: that is until

$$V + R = \frac{4c^2\rho}{J\pi d^2}$$

$$c^2 = \frac{J \pi^2 d^3 k t}{4 \rho}$$

The radiation is per sec.

$t \pi d k$ where k is a constant.

The equation then becomes

$$t \pi d k = \frac{4 c^2 \rho}{J \pi d^2} - V$$

$$\text{or} \quad t = \frac{4 c^2 \rho}{J \pi^2 d^3 k} - \frac{V}{\pi d k}$$

The convection V is probably directly connected f (Surface, t) with the (diameter)² and temperature

or $= q \, t \, \frac{\pi d^2}{4}$ in which case

$$\text{or} \quad t = \frac{4 c^2 \rho}{J \pi^2 d^3 k} - \frac{q t d}{4 \pi k}$$

$$\text{or} \quad t \left(1 + \frac{q d}{4 \pi k}\right) = \frac{4 c^2 \rho}{J \pi^2 d^3 k}$$

$$\text{or} \quad t = \frac{4 c^2 \rho \times 4 k}{J \pi^2 d^3 k \cdot (4 k + q d)}$$

$$= \frac{16 k c^2 \rho}{J \pi^2 d^3 k (4 k + d q)}$$

Abbreviated the results stand as follows

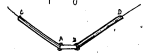
Heat units developed per cm per sec $= \frac{c^2 \rho}{J}$ where c is 70 per cm
c - current
J - 4·2

Heat units lost per cm per sec $= t k s + V$ where t is fluid temp
k is cond: const
s is surface.
V is convection

The a pair of standard Ω coils supplied by Dr. Muirhead came from London. Their EMF at the same temp: differed from that of our standard by less than 0·06 %. That is to say taking the EMF of our standard as 1·735 at a given temp. that of the Muirhead coils were between the limit certainty of 1·734 and 1·736 and in fact at one time no difference could be apprehended. Their res = 1·735

Tuesday 29th May

Res: of glass at high temperatures.



Two glass tubes, CAB, about 20 cms long and 0·8 cms in diam were connected at their lower ends by a rod of glass 4·9 cms long and 0·8 cms. diam. Two platinum disk electrodes about 1 cm. diam were fused solid between the rod and the tubes so as to be completely enclosed by glass at the points A + B but their edges almost appeared at the surface so that the thickness of glass over their edge must be small. Two platinum wires were riveted to these disks and lead out at the extremities of the tubes through seals at C and D.

This V. tube immersed in salt water showed perfect insulation, that is to say above 60,000 Ω. It was then placed in a sandbath and heat applied. Tinfoil was wrapped over the part AB. A thermometer, was dipped in the sand by the side of the rod AB. The two wires from C + D were taken to a delicate Mirror Galvanometer and 50 Ag/Ag cells. No deflection was observed, all the apparatus well insulated. On applying heat however below the bath the following results were obtained.

Time	Temp °C.	Galvo Deflectn.	Res: between C + D.
9.50	17°	0	> 60,000 Ω
10·0	121°	0·5 div	54,600 Ω
·16	163°	1·20 -	27,300 Ω
·18	182°	1·25 -	21,800 Ω
·28	218°	8·0 -	3,500 Ω
·30	236°	100 -	270 Ω
·32	242°	197 -	140 Ω
·35	248°	300 -	97 Ω
·38	252°	500 -	55 Ω

Stopped experiment at this point and let tube cool. Found tinfoil soft and torn. When cold put tube in water and found. Insulation perfect.

Lalande cells

No. 37. was made up with { ½ Bichromate of Potash
½ Lewis Lup

38 - " - - Bichloride of Tin.

39 - - - - sesquichloride of iron.

Iron grids.

No.	Date	Time	Hours at work	P.D.	EMF	Q.	R.
				Yu			
37	28.5.88	17.15	0	0.570	0.945	1.710	0.219
38				0.472	0.510	1.416	0.026
39				0.494	0.577	1.482	0.056
37	28.5.88	18.0	3/4	0.522	0.704	1.566	0.116
38				0.476	0.518	1.429	0.029
39				0.492	0.500	1.476	0.065
37	29.5.88	8.0	14¾	0.076	0.110		
38				0.070	0.080		
39				0.288	0.380		
39	29.5.88	17.0	23¾	0.186	0.240		

Weights of cores used for determining μ.

Norway	lb 4 oz 2.5	=	66.5	=	1885 grammes
Ulster	4.0	=	64	=	1815 "
S.C.	3.10.25		58.25	=	1651 "
N.W.	3.4		42	=	1191 "
5%	3.11		59	=	1673 "
10% Mg.	3.10.25		58.25	=	1651 "
Ruffine & Lamotte					550
" Hypophosphorus					490

Need have 5 oz

Formulae connected with the Magnetisation of solenoids applying strictly only to long thin solenoids

Let $\mathcal{H}$ = Magnetic field of solenoid only (line per sq. cm)
" c = current strength in abs: measure.
" k = susceptibility
" n = no. of turns of solenoid per sq. cm.
" N = total no. of turns
" a_s = area of solenoid
" a_c = area of core.
" l = length of solenoid and core
" $\mathcal{B}$ = Induction (line of force per sq. cm)
" $\mathcal{I}$ = Intensity of Mag: = $k\mathcal{H}$
" $\mathfrak{M}$ = Moment of solenoid and core
" m = " solenoid alone.
" v_s = volume of solenoid (mass if of second kind)
" v_c = " " core.

$$\mathcal{H} = 4\pi n c = m \times \frac{4\pi}{a_s l} \quad \text{or} \quad \bar{m} \times \frac{4\pi}{v_s}$$

$$m = a_s N c = \frac{\mathcal{H} v_s}{4\pi}$$

$$\frac{\mathfrak{M} - m}{l a_c} = \mathcal{I} = k\mathcal{H} \quad \therefore k = \frac{\mathfrak{M}}{\mathcal{H} v_c} - \frac{v_s}{4\pi v_c}$$

$$4\pi\left(\frac{\mathfrak{M} - m}{l a_c}\right) + \mathcal{H} = \mu\mathcal{H} = \mathcal{B} \quad \therefore \mu = 1 + 4\pi k.$$

When $v_s = v_c$ and $a_s = a_c$
this equation becomes

$$\mathcal{B} = \frac{4\pi \mathfrak{M}}{v_c}$$

Wednesday 30th May

Tried Resistance of Metallic surfaces in a solution of NaOH and distilled water with a copper plate as anode. The arrangement was precisely similar to that given on page 33. The current through the bath was 10 m-amp.

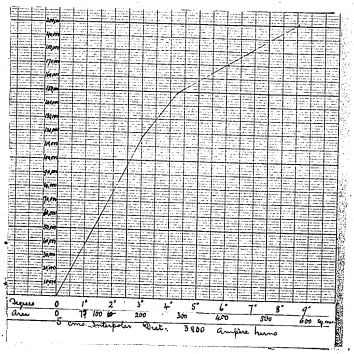
Without previous polarizing the resistances obtained were after steady polarization

(1)	Iron 18.5	(1)	Iron 8.5
(2)	Copper 20.5	(2)	Aluminum 20.5
(3)	Lead 20.5	(3)	Zinc 22.5
(3)	Zinc 21.5	(4)	Silver 23.5
	Brass 23.5	(5)	Lead 24.5
(4)	Tin 24.5	(6)	Nickel 25.5
(5)	Silver 24.5	(7)	Tin 27.5
(6)	Alumin: 27.5	(8)	Copper 30.5
(7)	Nickel 28.5		

Particulars of Multipolar Dynamo.

Ring outer circumference 263 cm. Diam 83.8 cms
Inner " " 215 " 68.6.
Area of ring Cross sectional 135 sq. cms.
No. of turns of wire 180.
Distance apart on outer circumference 1.46 cms.

At a speed of 825 revs: per min or 13.75 per sec. the volts at the terminal were 85 and the current 440 amperes. The res: of armature 0.004 ω. The Internal EMF would be 86.7, and this is the accumulation of 15 turns, 12 wts in parallel. This means 5.8 volts per turn of wire, and the no. of turns that cut the lines from one pole at the above speed is 2500 embracing an area of 119300 sq. cms. The average induction necessary for this EMF. is 48.6 Gauss. The field magnets were separately excited by the 100 volt mains. The linear circumferential speed is 3600 per sec, and the coils were on each turn = 17.8 + 15.2 = 33 cms.



The following observations of Pendulum swings were taken on the 29th May but their accuracy cannot be greatly depended upon as there was quite perceptible leakage current passing at time through the galvanometer and this could not be entirely got rid of owing to the dampness of the weather. However the leakage currents are given below.

The throws from the standard cell & 0.5T were.

136.4	272.8
137.1 ?	274.1
138.	276.0
138.8 ?	138.8
139.	278.

Mean 137.8.

Interpolar Dist 5 cms.

Current in Magnet	Ampere turns.	Pendulum Swing	Approx. Area Swept out	Amplitude of Needle deflection	Throw.	Lines of Force cut.	Lines per sq cm
2	3810	8'.35'	570	1.5 ±	75	200,150	350
		6'.45'	450	1.3	67	178,700	399
		6'.35'	440	1.0	63.5	170,000	386
		4'.25'	290	1.3	55.7	149,000	514
		3'.	200'	2.5	43.2	115,900	580
		1'.30'	100	0	21.2	56,900	569
		1'.10'	77	0	16.3	43,700	567

68.75
× 3800
4 18264

at 5 cms.
366530
324200
314480
272120
211680
103930
77412

Before taking Series

Throws from Condenser $0.5 \times 10^{-4} \times 1.2432 \times 10^{3} = 0.716 \times 10^{-1}$

20·7 ? 142·3
? 142·5
? 134·4
143·9
143·3
142·8

} Adjusted Mean 143·0

After taking series

20·3°C 143·2
141·8 } 142·5.

$$\mathcal{L} = \frac{d \times 0.716 \times 5225}{143.0 \times 146.57} = \frac{d \times 3741.1}{6657.95} = d \times 56.176$$

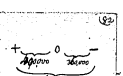
log 716 2·85491
5225 3·71809
57300

143 15·5314
46·87 6·6811
82345
74955 = 5614

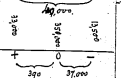
Time	Volts	31st May 1888 Ohms.	Ind. L.	Ampère turns	5 cm Throw	Corrected	Adjusted Mean	$\mathcal{L}$
10·12	113·6	32+240	0·0995	190·5	4	4	4·2	236
·27	112·7		0·0995		4·1	4·1		
·38	112·5		0·1009		4·2	4·5		
11·10	125·2	12+200	0·230	381	8·2?	7·13?	7·2	404
·18	126·2		0·200		6·75	6·75?		
·24	114·2		0·180		7.	7·77		
·30	114·2	12+360	0·179		6·3?	7·04		
·38	112·2	12+70	0·405	762	16 ?	15·8?	13·9	·781
·41	113·0		0·399		13·4 ?	13·43?		
·48	113·4		0·400		13·9	13·9		
·53	113·0		0·397		14	13·61		
·59	113·4		0·398		12·4?	12·46?		
12·24	113·3	117	0·13609	1905	32·4	32·54	33·1	1859
·33	112·9		0·13609		32·5	32·64		
·37	113·4		0·13609		33·9	34·05		
·46	113·3	75·4	0·20497	2857	49·7	49·7	49·9	2803
·50	113·0		0·20497		49·8	49·9		
16·02	113·0		0·20870		50·1	50·1		
·10	113·0	55	0·27243	3810	64·5	64·67	65·55	3626
·13	113·0		0·27243		64·2	64·37		
·18	112·6		0·27243		64·5 ?	64·67?		
·27	112·7	34·7	~~0·34605~~	4762	~~77 [illegible]~~	77	76·8	4314
·32	112·2		~~0·34605~~		~~77 [illegible]~~	76·7		
·37	113·0		~~0·34870~~		~~77·8 7~~	77·8		
20	112·7	36·2	0·40911	5715	89·4	89·6	89·6	5033
59	113·2		0·40911		89·3	89·5		
18·09	112·0		0·40572		88·7	89·6		
·27	112·5	29·6	0·54684	7620	107·1	107·147	107·4	6033
·34	113·3		0·54684		104·4	107·77		
·37	112·6		0·54684		106·5	106·87		
·45	113·0	25·9	0·68307	9525	117·7	117·7	117·3	6589
·55	113·3		0·68307		116·1	116·1		
19·02	113·2		0·68307		118·0	118·0		
·12	111·3	17·0	0·81946	11420	123·3	123·4	123·3	6927
·26	113·5		0·85673		122·8	123·8		
·28	123·4		0·14976		122·7	122·7		
·07	116·7	13·2	0·0265	13335	131·2	122·3?	125·4?	7044
·20	117·2		1·0265		130·	121·1?		
17·01	116·6		0·02724		129·2	122·1		
·13	112·5	11·2	1·07455	15240	132·4 ?	135·27?	135·63	7617
·18	112·2		1·0675		131·9	137·64		
·23	111·2		1·2861		131·9	132·29		
·34	112·2	8·9	12460	17148	137·2	135·46	135·25	7578
·40	111·3		1·2369		134·9	134·39		
·43	112·6		1·2369		136·4	135·86		
·52	112·0	7·31	1·3280	19080.	141·	140·85	141·35	7943
·55	112·0		1·3628		141·5	141·52		

Saturday 2nd June.

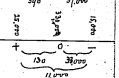
Edison system feed in E.R. chances



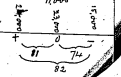
Archimedes in set.



Burke also in set



Edison also in set.



Meter experiment stopped, bottles removed but not opened.

Planimeter indicator 0.1 per sq cm. = 22.7 on bar.

Experiments were made with the multipolar Dynamo to find how much energy was wasted in friction in 1st Engine (Armington Simms running) the No 20 Dynamo (whose armature supplied 11 amperes thro' res.) and the shafting leading to the multipolar Dynamo.

	Front	Back.
The diagrams indicated	4.62	4.23
	Total 8.9 say	

16.05 clock

This was the energy consumed in overcoming the friction of the engine the shafting the No 20 armature, and the supply of 1100 Watts, in current.

17.6 & 17.11

2nd The belting was put on the multipolar armature shaft so as to drive the armature with the brushes off and the field unexcited.

The diagrams gave

Front	Back
5·89	
5·49	
	6·88
	2·50
5·69	4·69
Total	10·14

shewing 1·5 HP in overcoming friction of armature.

17.17 & 17.21

3rd The 11 amperes from the No 20 machine were taken off the pos and used to charge the field magnets. Bulks multipolar, whose armature ran with the brushes off.

The diagrams gave

Front	Back
	15·76
	15·63
	16·20
13·25	
13·22	
Mean 13·24	15·86
Total	29·1

Indicated H.P. wasted in Foucault currents 18·7.

The armature became very hot. The field coils were in parallel but ~~shots~~ ~~fairs~~ on each bar were in series.

* no paraffine wax simply pressed tight.

Experiments on the permeability of different magnetic substances.

Three cores were prepared as follows.

* 1st Pyrophoric iron reduced by hydrogen was mingled in a mould with melted paraffine wax. The dimensions of the core produced were

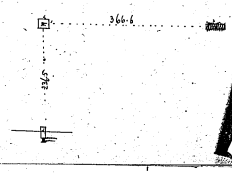
Length	15
Diam	4·8
Area	15·00
Volume	211·4
Mass	490.
Density	2·32

2nd Finely powdered Fe_2O_3 in a glass tube without admixture of paraffine. The mass of oxide being 190 grammes the dimensions of the column between ends

Length	15·2
Diam	4·0
Area	12·57
Volume	195·5
Density	1·02

3rd Coarse iron filings in a glass tube with molten paraffine wax.

Length	15
Diam	4
Area	12·57
Volume	188·5
Mass	381
Density	2·014



Coil Constants

Vol. of coil No.	Vol. c.c.	Radius	Area 4πr	4π/v	
1	291.1	2.469	19.87	0.4308	
2	307.6	2.538	20.27	0.0397	
3	324.5	2.607	20.67	0.0387	
4	342.2	2.677	22.48		
5	360.1	2.746	23.67	0.0349	
6	378.4	2.815	24.89		
7	397.1	2.884	26.15		
8	416.4	2.953	27.34		
9	436.1	3.022	28.65		
10	456.2	3.091	30.09	0.0275	
11	476.9	3.160	31.37		
12	497.9	3.229	32.78		
13	519.4	3.298	34.21		
14	541.7	3.368	35.68		
15	564.1	3.437	37.07		
16	587.0	3.506	38.59		
17	610.3	3.575	40.15	0.0206	

Have wrong editions except 17.

$\frac{m-m}{x\,\frac{4\pi}{v}}$	m-m	H	L
1.00	–		
	–		
	–		
0.0594	–		
	507	668	1075
	571	702	1273
	609	770	1379
	678	852	1525
	672	953	1625
	759	1053	1842
	816	1180	1979
	872	1260	2152
	951	1440	2391
	1080	1622	2672
	1176	1845	2021
	1279	1918	3196

Coil without Core.

n = 6.985
4πn = 86.52

No. of coils in coil.	Scale deflection dg	Obrach horiz. deflection	Current.	Moment cgs H. Comp	H.N.C. Average Field H Line per cm	m × 4π/v Average Field H Line per cm
1	0.48	0.556	0.291	9.449	25.12	407
5	0.88	0.518	0.271	17.326	117.	606
10	1.19	0.482	0.253	23.426	217.	644
17	1.40	0.449	0.235	27.560	345.	568
"	1.73	0.550	0.288	34.056	428.	702
"	1.90	0.590	0.309	37.403	453	770
"	2.10	0.600	0.341	41.340	499	852
"	2.35	0.725	0.380	46.262	557	953
"	2.67	0.805	0.422	52.562	618	1083
"	2.66	0.771	0.404	52.365	592	1079
"	2.86	0.87	0.456	56.303	668	1160
"	3.13	0.955	0.500	61.617	733	1269
"	3.11	0.950	0.498	61.224	730	1261
"	3.47	1.091	0.572	68.301	838	1407
"	3.90	1.21	0.634	76.775	930	1582
"	4.20	1.294	0.626	78.743	917	1622
"	4.55	1.35	0.707	89.570	1037	1845
"	4.73	1.40	0.734	93.120	1076	1918

	a.	Hydrochloric Acid	+	paraffine		m − m
1	0.55	0.552	0.294	10.824	25.14	138.00
3	0.82	0.522	0.284	16.156	73.5	
5	1.07	0.825	0.275	21.060	118.6	
10	1.51	0.485	0.254	29.737	219.5	
17	1.93	0.445	0.233	38.027	361.9	9.820
	2.24	0.548	0.287	44.099	432.8	9.600
	2.40	0.584	0.306	47.249	468.6	10.200
	2.61	0.644	0.337	51.383	449.7	11.400
	2.91	0.715	0.375	57.289	594.3	11.300
	3.30	0.807	0.423	64.947	619.9	12.770
	3.57	0.877	0.456	70.283	669.1	13.720
	3.92	0.957	0.501	77.173	735.2	14.470
	4.39	1.068	0.612	84.424	850.4	16.000
	4.[illegible]	1.195	0.626	96.663	918.0	17.660
	5.[illegible]	1.34	0.702	105.279	1029.4	19.560
	5.[illegible]	1.39	0.728	113.988	1067.8	21.500

No of Cycle	Post work State Deflection	Pull-up Attach Dem. Deflt	Current Mag. Mom.	Moment	H.	m	
1	0.61	0.563	0.295	12,009	25.44		
3	0.90	0.539	0.282	17.718	73.13		
5	1.19	0.525	0.275	23.428	118.62		
10	1.69	0.488	0.256	32.877	220.52		
17	2.08	0.448	0.235	40.944	344.16		
	2.41	0.524	0.275	47.448	402.54		
	2.70	0.586	0.307	53.155	450.17		
	2.95	0.642	0.336	58.077	493.19		
	3.32	0.719	0.377	65.361	582.34		
	3.75	0.820	0.430	73.826	629.93		
	4.05	0.874	0.458	79.732	671.42		
	4.45	0.965	0.506	87.607	741.32		
	4.92	1.060	0.555	96.860	814.30		
	5.43	1.173	0.615	106.900	901.11		
	6.10	1.320	0.692	120.091	1014.04		
	6.30	1.350	0.707	124.028	1037.08		
	Fe_2O_3						
1	0.55	0.552	0.289	10.828	24.94		
3	0.80	0.542	0.284	15.749	73.53		
5	0.98	0.512	0.268	19.293	115.69		
10	1.30	0.482	0.253	25.693	217.81		
17	1.51	0.44	0.231	29.727	338.07		
"	1.81	0.539	0.282	35.633	414.07		
"	1.95	0.578	0.303	38.390	444.03		
"	2.13	0.636	0.333	41.933			
"	2.40	0.71	0.372	47.249			
"	2.75	0.80	0.419	54.139			
"	2.99	0.86	0.451	58.864			
"	3.29	0.943	0.494	64.770			
"	3.65	1.041	0.545	71.858			
"	4.10	1.16	0.608	80.717			
"	4.68	1.30	0.681	92.135			
"	4.84	1.345	0.705	95.285			

Monday 3rd June.

Dried and weighed meter plates as follow

Plate No.	Weight 16.5.88	Joint weight 16.5.88	Weight 3.6.88	Joint weight 3.6.88	Gain	Loss	Dif.
1	21.7467	43.860	21.2397	43.8807	0.5377	0.5058	0.0319
2	22.1135		22.6412				
3	22.1071	43.698	21.5894	43.7112	0.5236	0.5116	0.0120
4	21.5908		22.1216				
5	21.3031	42.8775	20.7852	42.9093	0.5525	0.5148	0.0377
6	21.5675		22.1200				
7	22.1361	44.3466	21.6102	44.3566	0.5232	0.5142	0.0090
8	22.2234		22.7456			~~0.5232~~	
9	21.5071	43.8984	21.0075	43.9182	0.5200	0.4995	
10	22.3913		22.9110				
11	21.1765	43.2674	20.6622	43.2923	0.5294	0.5146	0.0148
12	22.0908		22.6300				
13	21.4184	44.3675	20.9059	44.3672	0.5267	0.5135	0.0032
14	22.9491		23.4613				
15	22.5124	44.9578	21.9994	44.9582	0.5132	0.5130	0.0011
16	22.4460		22.9592			~~0.5130~~	
17	22.2052	44.1070	21.6881	44.0975	0.5157	0.5196	0.0039
18	21.8929		22.4086				
19	21.2635	43.2652	20.8462	43.2743	0.5263	0.5173	0.0032
20	21.9017		22.4280				
					Mean	5.1261	
					Neglecting No 9	5.1268	0.002

No 9 had a flaw in the casting filled with sand which losing support fell away.

Res: of leads to galvo, moving wire to 3.1245
Magnet 740

1 C.C. gives through 0.54 @ 17.6°C

134
135.1 ?
134.2 ?
135
135.1 ?

Mean Temp room 19°C.

Mean 134.63 E being 1.4335 volts

$$L = \frac{d \times 0.7169 \times 5203}{134.57 \times 46.57} = 59.52\,d.$$

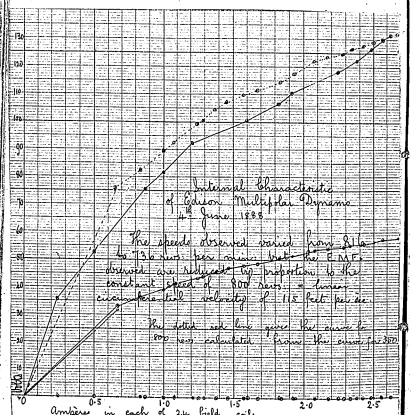
after series of readings 1 C.C. gives @ 20°C.

135.8
134.3
135.0
134.0
134.0

Mean 134.51 E being 1.43325

Mean for day 134.57 div. @ 1.4339 volts

Time	Volts 10^{-4}	Degree 88 Ohms	Ind. C.	T. Times Amplification	6 Times Ohms	10^{-2} R Corrected	Adjusted Mean	L.
11·05	112·9	24·58	0·0993	190·5	3·5	3·5		
13·29	114·7		0·10		4·0 ?	4·0	3·4	202
·36	114·5		0·10		2·6 ?	2·6		
·47	114·14	12 + 300	0·2	381	5·5 ?	5·5		
·50	114·0		0·2		6·1	6·1	5·9	351
·56	114·0		0·2		5·9 ?	5·9		
·58	114·0	—	0·4	762	12·1	12·1		
14·01	114·0		0·4		11·7	11·7	11·92	707
·09	114·14		0·389		11·7 ?	12·0		
·17	114·3	110	7'·45'	1905	30·2	30·33		
·21	113·5		7'·30'		29·9	31·014	30·31	1804
·24	113·5		7'·45'		28·9	29·57		
·28	114·3	74·92	11°·35'	2857	44·2 ?	44·01		
·38	113·3		11°·30'		40·3	40·61	42·49	2529
·42	114·2		11°·35'		43·6	43·61		
·49	113·5	54·07	15°·20'	3810	50·5	50·35		
·53	113·2		15°·15'		49·9	50·04	52·66	3068
15·00	113·9		15°·15'		54·1	52·25		
·04	114·7	41·90	18°·50'	4762	64·6	64·90		
·07	116·7		19°·30'		67·5	65·14	64·65	3848
·11	114·5		19°·55'		64·1	63·92		
·23	115·14	34·72	22°·20'	5715	77·6 ?	77·46		
·27	115·9		22°·20'		79·	78·85	77·03	4586
·32	114·13		22°·25'		75·5	75·05		
·54	114·2	25·21	26°·40'	7620	95 ?	95·0		
·59	114·0		28°·40'		91·5	91·5	92·96	5833
16·02	113·14		28°·40'		93·14	93·14		
·09	115·14	20·66	32°·40'	9525	100·6	99·39		
·12	115·14		32°·40'		103·7	102·49	101·71	6054
·15	115·7		32°·40'		105 ?	103·77		
·20	112·9	16·33	39°·15'	11430	109·9	110·3		
·24	113·5		39°·20'		111·1	111·1	110·70	6589
·28	113·1		43°·35'	13335	116·50 ?	116·61		
·33	112·0	13·29	43°·35'		115·	116·3	116·31	6923
·38	111·1		43°·15'		116·3	117·28		
·44	111·8		47°·35'	15240	119·8	119·69		
·49	110·5	10·49	47°·20'		119·7 ?	120·65	120·07	7143
·54	110·3		47°·15'		118·7	120·00		
17·07	113·2	8·66	51°·10'	17·145	122·5	120·3		
·01	113·14		50°·55'		123·5	121·91	121·11	7208
·10	112·9	7·21	53°·55'	19·050	125	124·51		
·14	113·2		53°·50'		124·9	124·84	124·74	7424
·18	114·2		53°·50'		125·	124·90		



Internal Characteristic
of Edison Multipolar Dynamo
14th June 1889

The speeds observed varied from 816 to 736 revs. per minute but the E.M.F.s observed are reduced by proportion to the constant speed of 800 revs. = linear circumferential velocity of 115 feet per sec.

The dotted curve gives the curve for 800 revs. calculated from the curve for 350

Leaf book 3. Page 3.

Tuesday 4th June.

Observed following set of characteristic values for the multipolar dynamo. All the field cores were magnetized separately from the No 20 Dynamo and all 24 were in parallel.

No. of reading	Amperes in field coils	Amperes in back coils	Speed observed	Speed estimated by ~~Lightfoot~~	Volts indicated on voltmeter	Volts reduced to 800 revs per min
1	6	0·25	816		36·5	35·8
2	12	0·50		816	57·5	57·4
3	21	0·88		816	77·0	75·5
4	24	1·0	816		83·2	81·6
5	29	1·21		810	94·0	92·2
6	38·5	1·60		803	107.	104·6
7	44	1·83	796		106.	108·5
8	46	1·92		784	109.	110·5
9	54	2·25		772	114.	118·8
10	57	2·38		760	116	122·1
11	59·5	2·48		748	118	126·2
12	61·5	2·56	736		119·5	129·9
13	63	2·63		730	120.	131·5

Notebook, N-88-05-24

This notebook covers the period May 1888-October 1889. It was used by Johannes H. Cuntz and Arthur E. Kennelly as a rough record book in the Galvanometer Room. Included are notes, tables, and calculations regarding magnetic induction, batteries, armatures, chemical meters, motors (probably for the phonograph), electrocution, multipolar dynamos, and other electrical experiments. Transcriptions of these records can be found in N-88-04-18 and N-88-06-06. Near the end of the book are 6 pages of notes by Kennelly about yellow fever, including a transcription from the *Medico Chemurgical Journal*. The front cover is labeled "Magnetic Induction Pendulum Expt." The spine is labeled "67." The pages are unnumbered. Approximately 150 pages have been used.

Only the yellow fever notes have been filmed.

Note

(1) That [illegible] in [illegible]
to certain [illegible] [illegible]

(2) [illegible] experiments
certain [illegible] particular conditions

(3) [illegible] is a [illegible]
[illegible]

~~(4) That~~

Blue effect [illegible]
[illegible] they have not seemed to have
a [illegible] effect

Extracts from
Boston Medical Journal
[illegible] Observation [illegible] year
ending Bridge Report of 1856
Boston Quarantine
[illegible] of [illegible] of
[illegible] a delightful season of
[illegible] with
[illegible] and
[illegible] of weather
[illegible]
[illegible] condition
[illegible] during varied
[illegible] the epidemic
[illegible]
in the hospitals which could
[illegible] to atmospheric
[illegible]. It does not lead air
[illegible] to have an integrating
effect which [illegible] only
[illegible] increased the number of
[illegible] of the [illegible] cases
[illegible] of the [illegible] cases
[illegible] immediately following the
other [illegible] state

p. 6 Patients known when attacked commences the disease begins with

		Deaths
Adm. June 22 ~~1st~~	162	39
July 1st	214	66
Mar	106	70
Ap	145	50
M	147	52
	158	39
July	172	35
Au	127	37
Sep	75	20
	102	20
	131	32
No	146	57
Dec		69
Jan	257	

1 The efficient cause of the disease is an acrid poison probably organic, which requires a certain temperature for its generation and exists in and affects special localities and persons. The poison adhering itself to the mucous surfaces of the [illegible] body. One of the primary effects of such contact when the quantity is adequate is to rouse the system into febrile reaction and to excite through the stomach

and institution an effort to respire the noxious agent. [illegible] to [illegible] the compound effort is somewhat [illegible] but is mutually aided by the action of [illegible] aided. In the event of the exhalation [illegible] that all of the function is to act upon the epithelial structures of the body (exclusively).

1858 Vol III Philadelphia p. 288

"[illegible] and docks were more or less filthy. In one of the [illegible] there was a quantity of damaged coffee deposited. Its smell was highly fetid [illegible] orders were issued to have the ship probably cleaned [illegible] the filth removed. Still low [illegible] the disease continued to spread until it prevailed in most quarters of the city every street appearing to be charged with miasmata. The unventilated courts in densely-populated close alleys were the greatest sufferers.

As on former occasions the members of the medical profession suffered severely out of 210 who had attended fever 16 were attacked and died.

Dr. [illegible] states that a certain degree [illegible] this opinion is contested by the wide of the paper.

1859 Very clear + remarkably scientific paper by Lanyon on Yellow fever up Hill at Jamaica. Well worth reading for general interest alone. He concludes.

"It appears that the occurrence of the disease was preceded by a moderate quantity of rain and its cessation in Nov. soon took place under the influence of the heavy rains which commenced in the 4th. The causes of the fever however do not seem to have been altogether removed by the rain but their action was

[illegible] suspended or rendered less [illegible] [illegible] [illegible]

Notebook, N-88-05-31

This notebook covers the period May-December 1888. There is also one entry from February 1889. At the beginning of the book are several pages of instructions from Charles Batchelor to Robert T. Lozier regarding experiments on a multipolar dynamo. Most of these experiments appear to be concerned with "Fo[u]cault currents" (eddy currents). The remainder of the book contains the results of experiments probably conducted by Lozier, along with scattered entries by Arthur E. Kennelly. There is also a 3-page list of contributors and contributions for a birthday "testimonial" to Edison. The front cover is labeled "Mr. Lozier No 503" and "Multipolar Dynamo May-Dec. 1888." The inside front cover is inscribed "Mr. Lozier Book 503 May 31st 1888." According to a list of laboratory experiments, ca. 1903, this book was also assigned the number "69." The pages are unnumbered, and several pages have been removed from the book. The book was used in both directions. Approximately 60 pages have been used.

YE-172 N-88-05-31

McLgcir

Book 503

May 31st 1888

May 31st 1888

Multipolar Dynamo.

Run at 820 Rev.

#1 Put all magnets in multiple arc — making ~~[illegible]~~ in multiple or about ~~[illegible]~~ ohms of field

~~[illegible]~~ charge to ~~[illegible]~~ field

100 Volts

Run 15 minutes without load

~~[illegible]~~

Take increase of temperature on iron core & see if it is sensibly hotter at the ends than the middle, by using two thermometers

Take speed — & Volts — & amps — & time

Be sure that each alternate pole is P + N

Take amperes in field & be sure to use resistance in external that will carry at least 20 amperes

Multipolar Dynamo May 31 1888

#2 Exp. With Magnets in Series
(12 double spools in M. a.) as
they are now —
Run 15 minutes with 6 amperes
in magnet circuit —
No load on machine
Take temperature of iron
(middle & ends)
Full speed 820 Rev.

Multipolar Dynamo May 21st 1888.

#3 Magnets 24 in M.A.

Put on load of 400 amp.
and if volts not too low
get on up to 600

Run only a short time &
take heat note whether
leading wires hot as
well as armature wire

Ogden

Connect all magnet spool in multiple arc & charge with 100 volts from the #20 ——

Put on 440 amperes on armature & take volts at brushes.

OS

#5

June 4 1888

Multipolar Dynamo -- May 31st 1887

#4 Exp.

Charge these with same volts
Have same current passing
as in #1
Run full speed and take
increase temperature of iron
after 15 minutes

Generator Comments #1 June 1st/98

Tested Started at 8.40

Fields 2 coils in series
12 multiple-alternate
poles

Ran for 15 minutes

Temp of room at starting
80°

100 volts at field terminals
10.4 amperes in field
No current on armature
circuit

Temp of armature in
middle

Temp at sides

Speed 820

found fault thermometer
ran for ten minutes more
after shutting down for
15 minutes —

Started at 9.10
Stopped at 9.20

Temp of Field middle 198°
" " " Side 230°

Volts 97
Amperes 10
Speed

Foucault's Generator #4 June 1/88

2 coils in Series 12 in Dual.

~~Top of~~ pole cores on top north pole

(pole pieces "internally" bottom south "

Speed - - 800 - 800 at end 816

Amp in field - 11.5

Volts at terminals - - 101

Time started - 11.25

Time ended - - 11.40

Length from -

Temperature of armature middle - 131°

" " " side 129°

Temp of " at start 105°F (Mean)

" " Room 76°F

Stopped for 10 minutes &

resumed at 11.50 - ran

for 10 minutes

Volts 100

Amps 11

Speed 800 - 817

June 1/88

24 Coils in Multiplex
Alternate Poles
Test started at
" Ended at
Armature
Speed
Volts
Amps in field

Focault Currents
June 2/88.

24 Coils in Multiplex ~~series~~ alternate poles

Test started at 2.10
" Ended at 2.25
Amperes in field 5.5
Speed 2.14

Temperature of Armat in middle 93
" " " at ends 103
" " Room 72°F

Test shut down for 15 minutes
Started at 2.40 ran for
10 minutes under above conditions

#5 Multipolar — June 2. 1888

Lake indicator cards as follows:—

1st Engine running with #20 running & countershaft running but no belt on Multipolar & no load amp where except 1½ amperes on #20 & charging do

2" Same with Multipolar running empty

3 Same but with the 1½ amp on #20 running through field of Multipolar all on M. A.

Small amounts

#2 June 4/88

Coils 2 in series 12 m.a alternate
d.c.

Started at 11.2

Amperes in field 5.5 after 5 minutes
changed to 5/4 amp.

Speed 820 revolution

Shunt down for 15 minutes

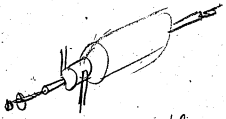
Then ran for 10

Y. Field 818

Temperature of armature middle 146
" " " end 157

Room

June 7 1888



— Magnets in place but not charged

— Hang the armature in centres so there is no friction

— put brushes on lightly

Pass 25 or 30 amperes through the brushes + armature & see if it turns around or takes any direction

Move brushes a little either way to see if it will do it better

June 5/88

[illegible] started at 8.20

[illegible] through field

Volts at field terminals

" at Armt "

Amperes load on armt

Speed

[illegible] stopped

Speed 810

Amperes through field 41.5

Volts " " 100

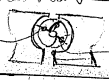
" on Armature 112

Multipolar Dynamo 1888 June 4

#6

See how little current you can pass through the magnets to get 112 Volts out of the armature

Took a 42 [illegible] magnet mounted
having between two poles passed
a current of 8 amperes through
a motor. The field being initially
disconnected, at beginning of
test set brushes at angle of
45° (14 bars each from neutral
point but not on [illegible]).
Measured torque & speed found
for 2 bars which was
found to be the point of maximum
effect. Recorded [illegible] points.
At speed 800 revolutions — current
at start 24.5
[illegible] 21.5 +



Multipolar Dynamo. June 4 1885.

#7. Take a saturation curve of Multipolar as follows:—

Disconnect all magnets but one pair & set brushes for that one pair

#40

June 8/88

Experiment to determine
Focault's currents in Multiphase
Dynamo
Took #1 machine with pole
pieces cut out & stripped
a #1 Armature - put on the
Lacing of tape
Test started at 3.10 P.M.
Speed
" at end 1680 - 1690 = 1685
1620 1610
Amperes through field 2.55
" armat. 2.55
Increase of 10° in temp.

June 9/88

Lined above exp on #1 dyn
(used as motor in Kielblin
Office)

Test Started 9.40
" ended 12.00
2.20

Speed 1755
Amp through field Started
with 4.25 ended with 3.5
Temp of room 78° F
" " Armat (Emp) 120° F

Full Speed

June 11/88

Multipolar Dynamo

Test started at

Amperes through field

volts at brushes

~~Speed~~

Amperes on dynamo

Speed

volts	amps	volts	
60	180	90	160
	360		400

440
200
~~360~~
640 — 80 volts
amps

60 amps through field

Overall currents

June 11/88

Took a #1 Armt Shaft turned on bobbin of wood projecting beyond field pieces

in which was wound red vulcanized (vulcanized) iron wire.

Test started at 8.40

Speed 1680

Amperes through field #.1

Temperature from 78°

" " Armt 115°

Dimensions of Dynamo Room

Side "A" = Facing South Wall.

Side B

Side C = 106 / 3 / 49½

Read mining from tribe Underm

Side — stope on

upper 49.[illegible]" + 15½" + 11½"

middle 42.7" + 20½" + 7⅛"

lower 40.7" + 11[illegible]" + 7⅞"

(To)	17 5/16	64	70.8
		62	68
(U)	12 5/16	47	31
		48	33
(O)	7⅛	32½	57
		180	296

Gold 3 3/4 oz. 2 dwts

22 / 4 / 41

Upper	Middle	Lower	Tribe mining from tribe
42.7	49.	40	7
1 8½	1 3½		11
7½ / 8	(To) 4½	(To)	5 3/4
	~~[illegible]~~	13	3
12 5	12 10		
7 3	7 3	7 3	
6[illegible] [illegible]	70 [illegible]	62 ~~30~~ ½	
5 4	11	[illegible] 26	3
1 4	6	(To) 25 7	(U) 14. 6
8		8	
	17 1	4. 6/13	~~16~~ 17
47 ½	48.	48	9
~~14 10~~	19.	13 2	
15 2	8	5	11
7 4	8	5	5
22 6	28 8	19	6
	49		

Gold from Dynamo Room (O)

Aquiano Leads

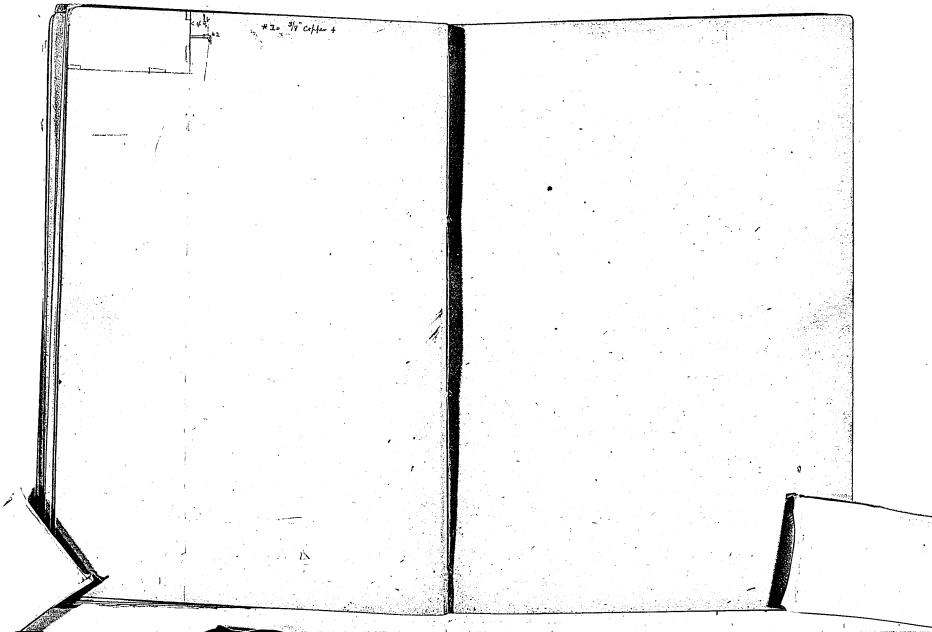
24.9	26.5		
7	7	654	
31 9	33 5		
27 6	27.6	5/8	1/2
13.11	13.11	T	T
5 7	5 9		
		4	4
57	57 2	5/8	1/2
5/8 Connectors			6
2	1		
4	2		
2	1		
2	1		
	4	63	
10	4		
	13	154	

—

64.9 - 9	41	26.0	
70 - 9		3.9	
62 - 6		29.9	
47 - 6		21.1	
48 - 1		23.9	
48 - 9		20.6	
31 - 9		5/8	1/2
33 - 5		64.49	70.49
57 - 2		62 - 6	48 - 1
57 - 2		47 - 6	31 - 9
57 - 58		48 - 9	33 - 5
5			57 - 2
522			57 - 2
65			
457		22 1.30	296 28
		224	298
21.1 - 23.9		298	
20.6		22	298
		226	29.9
41.7	23.9	41.7	271
		182	
		182	271

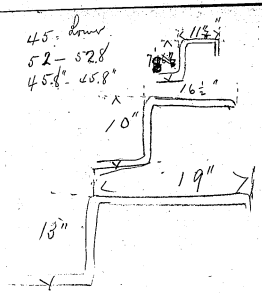
2 00 5/8" copper rod
~~200~~
2 60 " 1/2" " "
~~120~~ " porcelain insulators 2 x 11/16
10 connectors for 5/8" rod
3 " " 1/2" "
4 T " " 5/8" "
4 " " 1/2" "
4 ⊏ " " 5/8" "
6 " " 1/2" "

2 65 for 5/8" copper rod
2 00 " 1/2" "
~~200~~ 225 " porcelain "insulated" knobs 2" x 1 11/16
1 05 " " " 1½" x 1 7/16
30 connectors (copper) for 5/8" rod
20 " " " 1/2" rod
4 T " " " 5/8" rod
4 " " " " 1/2" "
6 ⊏ " " " 5/8" "
4 " " " " 1/2" "
4 feet 7/16" hard rubber tubing
.16" hole
16 6" — 1" polished fine jet brass tubing cut in 4' 1½" lengths
6 ceiling flanges
3 ornamental brass chandelier
2 including canopies for 1" tube end bells as per our letter Aug 7/6


#2= 3/8" Coffee t

# of tacks	thickness of tacks	Length
# 1	3/16"	2' 8"
2		2' 8"
3		2' 8"
4		1' 7"
5		2' 5"
6		2' 8"
7		2'
8		1' 7"
9		2'

45 hours
52 – 52.8
45⅝" – 45.8"



Lumber

12. 6. 89

22.10 Commenced running

armature made with simple
iron core covered with iron
tape + canvas. about 4000
revs. per min = 66 × 1.3
= 88 feet per sec
Field charged by 110 volts
diameter 8 feet

22.20 Stopped running

:23 Temp taken 86° + 90° F
hush side / pulley side

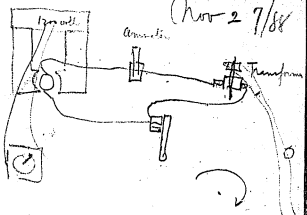
bulbs in cotton waste pressed against
sides

22.31 Commenced running
wooden core & iron straight
wire armature covered in
tape + canvas
Conditions same

:46 Stopped running

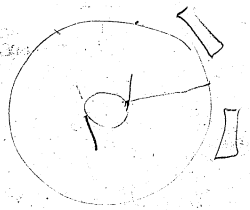
:52 Temp taken in centre on
canvas. Temp 90
Bar slightly better than morning pressure

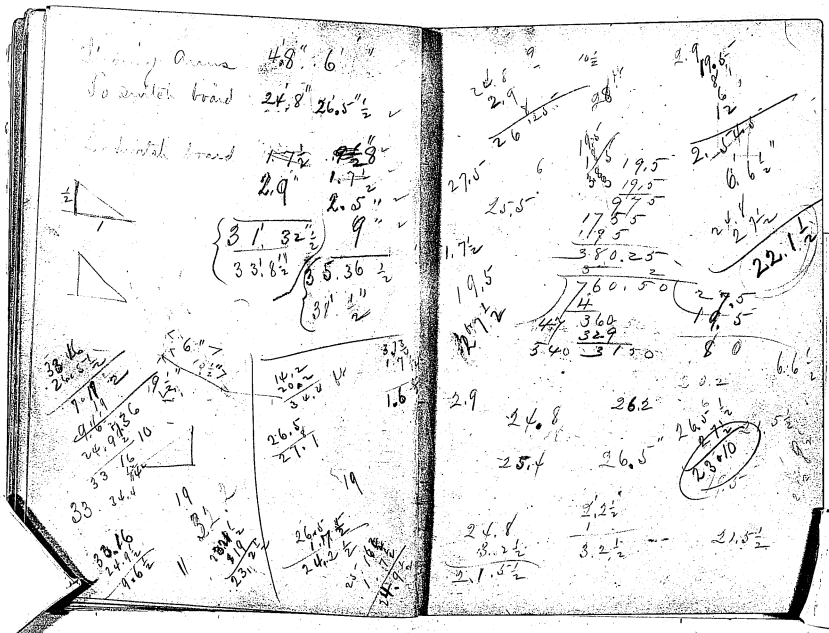
Nov 2 7/88



Runs best with brushes opposite on lower commutator & no brushes on upper comm. for half an hour at (fully) 1000 volts pressure
Should not exceed 1 amp.

Now last started 13.43
volts 13.70 } at 13.5-8 load set
amp 1.9
~~Stopped~~ 13.70 shut down at
amp 1.9 14.13 on a very hot bearing





Bend one rod 9 1/4" from end at angle of 45° thus -
9 1/4"
9 1/4" 7"
19"
27"
26"
(Short)
9.7
1 7
9 1/4
19"
19"
6"
24'8"
26.5 1/2
24.8
3.1
21.6 1/2
26.5 1/2
3.1
23.4 1/2
2.19"
9.7
16.2
24.15
26.3
34.4
23.1
11.3
24.6
1.7
25.11
24.6
26.5 1/2
24.11
24.10
26.6
24.10
26.6
9.16
10.4
9.16
24.10
26.6
24.10
26.6
24.10
26.6

Monitpolar Dynamo Dec 3/99

Field 42 amp
Volts 160 volts

10.57 am
160 volts
42 amperes on Field
95 " " amp meter (Load
25 deflects
2 wires
11 am.
155 volts
40.5 amp on Field
48 deflect
220 on amp meter (Load)
4 wires

11.03
149 volts
37 amp on Field
270 amp on Load
69 Deflec
6 wires

11.05
143 volts
36 Amperes
370 amp on Load
80 Deflec
8 wires

139 volts
34 amp on Field
425 amp on Load
92 Deflec
10 wires
138 volts
34.5 amp
102 Deflec
12 wires

131 volts
127 Volts (Ayrton & P)
32 Amp on Field
Amp meter off scale
109 Deflec
14 Wires

129
123.5 volts (A+P)
11.12 30.2 Amp on Field
185 Deflec
16 Wires

Shut down at 11.14
Temp 132.5° 11.20
" 135° 11.42

Started 12
volts 160 A+P
39 Amp on field
X 55 Amp on Ammeter
22 Deflec
2 wires

12.02
149 volts
37 Amp on Field
X 150 Ammeter
48 Deflec
6 wires

12.03 138 volts
36.5 Amp on Field
86 Deflec
X 230 Ammeter
10 wires

12.04 136.5 volts
32.2 Amp on Field
110 Deflec
280 Ammeter
14 Wires

Time 12.06
Volts 115
Amp on field 28.7
Deflec 130
Ammeter 330
Revs 18

Time
Volts 107
Amp on field 26.2
Deflec 148
Ammeter 325
Revs 22

Time 13
Volts 105
Amp on field 25
Deflec 120
Ammeter 372
Wires shut down at 1 P.M. Hot bearing
Temp
13-10 = 204.5°F 13-23 = 205°F
13-20 = 205°F

~~15-30~~

9'-8"

11—9½ 12-2 rectangle

25.17½
11.9½
14.8

25.17½
12.

26.5½
12
14.3½

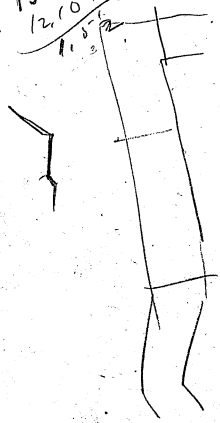
28.10
11.9½
12.10½

Outside one to wall 26.5½
Cut off rod 14.3½"

Inside one to wall 24.8
Cut off rod 12-10½

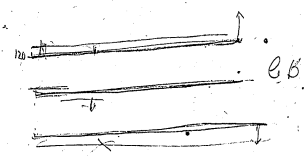
17½

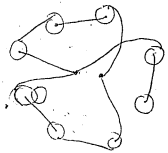
13.15½
12.10
1.5½

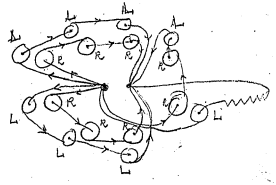


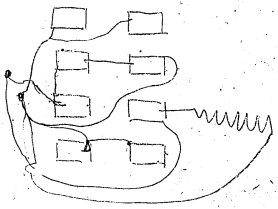
Time	Volts	Amp	Wires	Armature	Defl
15.30	160	41	2	95	28
·35	150	37	6	280	50
·40	138	33	10	440	78
				430	
				230	
·42	120	·28	18	300	115
·45	114	27	20	360	114
·50	109	25	22	370	125
·55	104	24	26	380	109
16.00	Speed 830			385	
·12	101	25	19	340	95
16.40	98	23.5	19	333	83
Speed 830	100 amp				
17.00	99	21	19	335	85

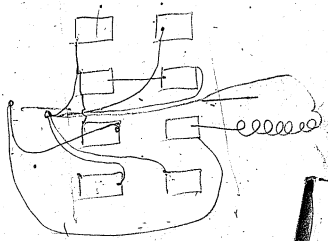
·30 Shut down
35 Lamp 218°7
48 " 225
50 " 221






L
R
L
R
L
R
L
R
L
R
L
R
L
R
L
R
L
R
L
R
L
R





19. 40 Commenced running

62 amperes in field cct.
37[illegible] indicated 1 log. Def
20 wires
130 volts

20. 10
55 amperes in field
370 indicated
20 wires
123 volts
21. 10 Shut down to fill bunker
21. 18 1930
35 221

22:30 Started again
53 Amps. in field
360 indicated
20 wires
115 volts.

23:30
48 Amps. in field
350 indicated
20 wires
110 volts

24:30
47 Amps. in field
345 indicated
20 wires
110 volts Rev. 725

1:00
44 Amps. in field
325 indicated { Steam low
20 wires
volts 102 Rev. 720

2:00
Amp. in field 45
indicated 325
20 wires
volts 103 Rev. 705 } steam still low 70 lb
2:30 Rev. 750
3:00
Amp. in field 45
Indicated 325
20 wires
volts 104 Rev. 730
Brushes gave out + shut down for repairs
Temp of Arm. 250°

Started up 4:30
Amp. in field 57
Indicated 375
volts 120
20 wires Rev. 790

5:30
Amp. in field 49
Indicated 360
20 wires
volts 113
6:00
Amp. in field 48
Indicated 360
Volts 112
20 wires
Rev. 700
6:30
Amp. in field 47
Indicated 350
Volts 112
7:00 20 wires readings same
Shut down again to repair
Brushes
Temp. of Armature 260
~~Stopping again by stretch of~~

2 - 3/16

23 1/4"

4"

2 5/16"

24

5/8

4"

1 5

2 5 3/16

2 1/16

4

15/16

1.52

1.02

2.11.89

75.57 29.750

65°

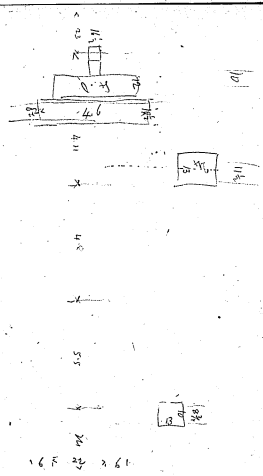
50

62

57

54

0.92



5'4"
11"
5'2
9"
6.1
8.0
6.6
7.9
8.6
9.3
2.6
3.6
7.3
8.3
8.6
14.6
15.1
14.3

1
5
5
4.5
1
4.5
1
11.5
8.2
14.1
5
5

Name	Amt	Mr B	Other county	Name	Amt	Mr B	Other county

Name	Amt	Paid	Pin comfort	Name	Amt	No B	Pin comfort
Tilman	$1.00	yes	Dec 15th/85				
W. P. Dickson	1.00	+	" 15/85				
Rube Hayworth	1.00	+	" 15/85				
Geo Gilmore	1.00	+	" 15				
Jim Duncan	1.00	+	" 15				
Sam Jenkin	50	+	" 15				
Hos. Hewston	50		" 15				
Alfred Sudeeke	1.00	+					
W. Westring	50	+	" 15				
Titus	1.00	+	" 15				
~~Henry Pierce~~							
Henry Pierce		+					
J. B. Pierce	50	+	" 15				
R. Frasenden	1.00	+	" 15				
Wolke	1.00	+	" 15				
J. Gnyard	1.00	+	" 15				
John Lind	1.00	+	" 15				

Testimonial

Name	Amt		When cash	Name	Amt		When cash
			Pay				
Mr. Brinn	100	+		J. Lehmann	100	+	Dec 15
" Ad Grind	100	+		A.J. Brigham	100	+	" 15
" Elwell	100	+	Dec 15	Ed Ronsinger	50	+	" 15
" English	100	+	Dec 15	Prof Hilmundy	100	+	" 15
" Fence	100	+	" 15	Jno Dorr	25	+	" 15
" Geo Ott	100	+	" 15	Geo Sloane	50	+	" 22
D.H. Deem	100	+	" 15	J. Allen	100	+	+ 15
Geo Hofmeyer	100	+	" 15	J. Hayes	50	+	" 15
A.E. Kimmell	100	+	" 15	H. Mellen	100	+	" 15
Henry Foulke	50	+	" 15	H. Kaiser	100	+	" 15
Geo Brine	100	+	" 15	Jno Dahl	100	+	" 15
Del Foulke	100	+	" 15	Harbinger	50	+	" 15
Jc Bilotinke	100	+	" 15	Dewonald	50	+	" 15
Geo Dettine	100	+	" 15	Jno Hunter	100	+	" 15
Jno Mullen	100	+	" 15	R. Hoyt		+	" 15
Jacob Wilde	100	+	" 15	J. Gillington	100	+	" 15
D.J. Marshall	100	+	" 15	Thompson	100	+	" 15
J.W. Gladstone	100	+	" 15	Geo Allen	50	+	" 15

Bind

$E = \frac{5}{1200}$

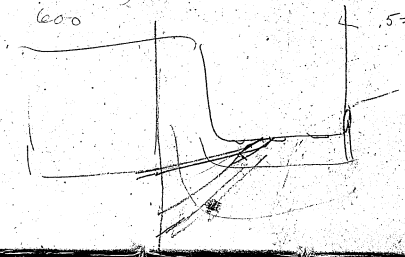
$\frac{200}{1200}$ $\frac{6}{1200}$

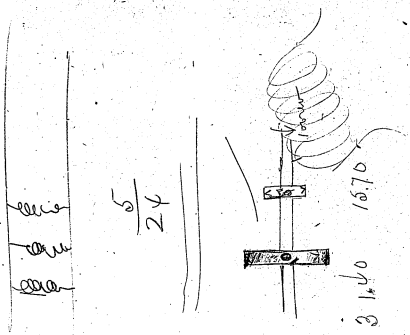
$i = \frac{E}{R}$

1200) 5000

600

$.5 = \frac{E}{1200}$





Notebook, N-88-06-06

This notebook, which covers the period June-July 1888, is a continuation of N-88-04-18. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. There are notes, drawings, and calculations regarding armature windings and dynamos, including multipolar and municipal dynamos and a plating dynamo; batteries; non-magnetic watches; and the "new Edison voltmeter." There are also notes on electrocution experiments, the electric light system at Llewellyn Park, and the calibration of instruments, along with calculations on the cost of procuring zinc sulphate. Among the experimenters whose work appears in this book are F. P. Bergh, Arthur E. Colgate, Johannes H. Cuntz, and Oren S. Hussey. Attached to the inside back cover is an index. The front cover is labeled "Record Book No. 3. Galvanometer Room." The back cover is labeled "512." The spine is labeled "48." The book contains 88 numbered pages followed by 8 unnumbered pages. Some pages were removed before the book was paginated. Numerous graphs have been pasted into the book.

The index has been filmed first.

Armatures – 47
Ammeters – 52 – 39
Accumulators – 13-23-25
Converter – 9
Dynamo – 53-54-55
Dynamo Plating – 72. 73
" Multipolar – 1. 2. 3. 4. 5. 6. 15. 16. 17. 18. 19.
" Municipal – 10-11. 12. 13. 14.
Edison Voltmeter – 69. 81.
" System – 19. 25. 27.
Glass tubes – 61
Electrometer – 82 – 88
H – 44. 111. 112. 113. 63. 64. 65. 66. 67. 68.
Leads Engine room – 61
Meter Plates – 45. 50. 61. 62
Mason Cells – 69. 76. 84. 91. 92.
Physiological – 71. 72. 74. 75. 78. 79. 80. 85. 86. 87
Pendulum – 7. 58. 60. 69. 71. 76. 77. 83.
Permeability – 20. 21. 22. 26. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37
Phonograph Motor – 48. 46
Phonograph Motor – 49-50.
Roberts Cells – 23. 24-44-49. 69-70-84-85-89-90-91
Standard Cells – 19. 28
Voltmeter – 51
[illegible] – 45. 48. 51. 56. 57.
[illegible] Sulphate – 8. 59.

x E-172

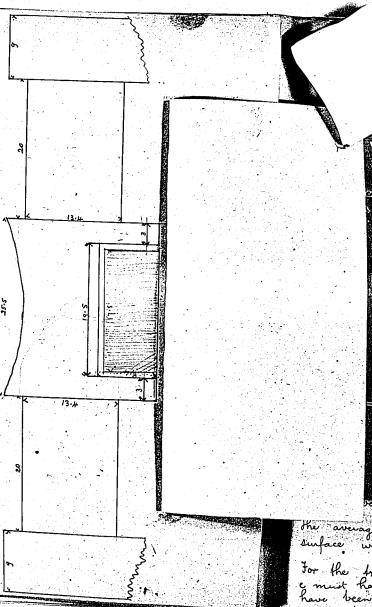
N-88-06-06

Record Book
of observations
in the
Galvanometer Building
Edison Laboratory

Commenced 6th June 1888
Concluded

No 3.

Radial Section through axes of a pair of magnet cores in the Edison Multipolar Dynamo, lengths in cm:



with

dynamo.

of layers on each magnet
total at 25 and there being
18·5 turns to the layer the
number of active turns is 3875

formula for a double horseshoe
on page 109 converted into C G S. U

$$\frac{2.54\,P \times 1.6 \times 6000}{\frac{3600\,d}{D} + \frac{2\,l}{a} + \frac{3\,s}{d}}$$

corresponding force in this case	2X3875c
dyne-hours - - - -	1
turns-passing surface - - -	390
length of mean armature curve, here	78
cm - - - -	112·5
length - - magnet - -	60
cm - - - - -	1420

$$\frac{2 \times 3875 \times \frac{1}{2.54} \times 1.6 \times 6000\,c}{\frac{3600}{390} + \frac{78}{112.5} + \frac{180}{1420}}$$

2.1×10^6 for value of z

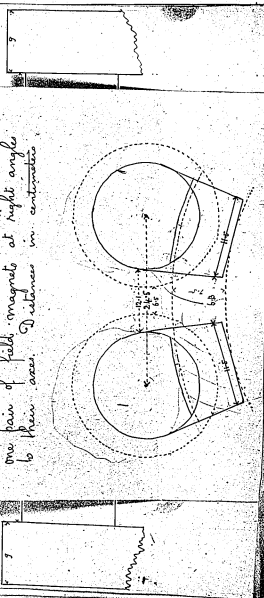
Numerical Evaluation.

the average field for the 135 gems of ring surface would be $\frac{2.54}{1.35} \times 10^8 c = 2.0 \times 10^8 \times c$.

For the trial on page 79 book 2 the current must have been 0·11 and the field should have been 2.2×10^3 or $\frac{22}{10}$ Gauss. It was reckoned at $\frac{22}{19}$ or 33·4 c. shunt.

Radial Section through axes of a pair of magnet cores

Section of Edison Multiplex Dynamo through one pair of field magnets at right angles to their axes. Distances in centimetres



(C)

Data connected with the Multiplex Dynamo

The number of layers on each magnet coil being stated at 25 and there being about 155 turns to the layer the total number of active turns is 3875

Happy's formula for a double horseshoe magnet of each iron on page 109 converted into C G S. U.

$$Z = \frac{2.54\,P \times 1.6 \times 6000}{\frac{3600\,d}{S} + \frac{2\,l}{a} + \frac{3\,L}{A}}$$

where P is magnetizing force in this case 2X3875c

d	clearance	1
S	lines passing surface	390
l	length of mean armature curve here	18
a	area	112.5
L	length of magnet	60
A	area	1430

$$Z = \frac{2 \times 3875 \times \frac{1}{2.54} \times 1.6 \times 6000\,c}{\frac{3600}{390} + \frac{18}{112.5} + \frac{180}{1430}}$$

$$= 2.5\,c \times 10^6$$ for value of z well below saturation.

The average field for the 135 gems of ring surface would be $\frac{2.5}{1.35} \times 10^5 c = 2.0 \times 10^5 \times c$

For the trial on page 79 book 2 the current c must have been 0.11 and the field should have been 1.2×10^3 or 12 Gauss. It was reckoned at 49 or 33 % short.

Taking the same calculation in Kapps method.

$$Z = \frac{1.6 \times 7750 \times c}{\frac{1800 \times 0.79}{60} + \frac{14}{18} + \frac{75}{22}}$$

$$= \frac{12400\,c}{23.7 + 0.8 + 3.4}$$

$$= \frac{12400\,c}{28} = 443\,c$$

$$\therefore = 443 \times 6000\,c = 2658000\,c = 2.7 \times 10^6\,c$$

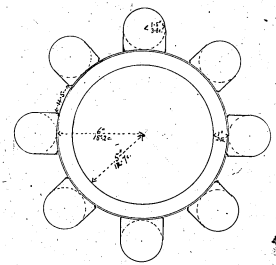
To saturate the cast iron cores would probably require about 10,000 ℓ per sq. cm. and there are 143 sq. cm so that 1,430,000 would be required $= 1.43 \times 10^6$

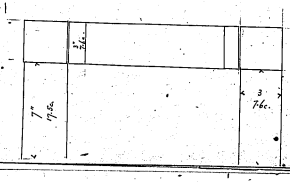
$$\therefore c = \frac{1.43}{2.7} = 0.53 \text{ or } 5.3 \text{ amperes.}$$

If 9000 lines would saturate $c = 4.8$ ampere

(2)

To determine the winding of a transformer ring whose diameter is 12" external running at a circumferential speed of 1200 ft per sec. there being 4 magnet in series (8 coils), the pressure being 1100 volts and the external P.D. 112 volts.





1st Required the winding to bring the core up to 90% of saturation. Say to 8000 lines per sq. cm.
The area being 45.4 sq. cm. 363,200 lines will be required. Here by Hopkinson's formula

$$Z = \frac{0.8\,P \times \frac{6000}{2.54}}{\frac{3600\,d}{S} + \frac{l}{a} + \frac{3\,C}{A}}$$

where $d = \frac{1}{8}$" $= 0.32$ c. — 0.125"
$S = 57.76$ sq. cm. — 9.0 sq. in.
$l = 120$ cms. — 5 in.
$a = 19$ sq. cm. — 3 sq. in.
$C = 50$ — 20.
$A = 45.4$ — 7.1

$$Z = \frac{0.8\,P \times 2{,}360}{\frac{3600 \times}{17.3} + \frac{12}{19} + \frac{150}{45.4}}$$

$$= \frac{1{,}885\,P}{20.8 + 0.63 + 3.3} = \frac{1888P}{24.73} = 76.34P$$

$$\therefore P = \frac{363200}{76.34} = 4760$$

Checking the calculation in Inches

$$Z = \frac{0.8\,P \times 6000}{\frac{3600 \times .0250}{9} + \frac{5}{3} + \frac{60}{7.1}}$$

$$= \frac{4800P}{80 + 1.7 + 8.4} = \frac{4800P}{90} = 53.3\,P$$

$$P = \frac{363200}{80} = 4500$$ practically the same

Thursday 7th June.

Took following set of Characteristic observations on Multiplex Dynamo running at slower speed to see if the speed of revolution visibly interfered with the saturation point.
The observations are plotted on page 89 book 2.

Time	Speed Observed Revs/min	Assumed Speed Revs/min	Current in Volts act.	Current in each coil	Volts by Voltmeter	Volts by A.H.	Volts reduced to 350 revs	Volts reduced to 800 revs
9.5.	348	348	16.0	0.67	36	33	33.2	75.9
	~~348~~	348	20	0.83	36	34.2	36.4	83.2
		348	24	1.00	38	39	39.2	89.6
		347	26	1.08	40	41	41.35	94.52
		346	30	1.25	43	43	43.95	99.44
		345	31	1.29	44	43.5	44.0	100.6
	340	344	33	1.375	45	45	45.8	104.7
		343	35	1.46	45	46	46.95	107.4
		343	38	1.58	46	47	47.96	109.7
		342	40	1.675	46.5	47	48.8	111.56
		342	44	1.83	47	49.0	50.15	114.6
		341	46	1.92	49	50.0	51.3	117.3
		341	50	2.08	50.5	52.0	53.37	122.0
		340	52	2.17	51	52.5	54.02	123.4
		340	55	2.29	52	53.0	54.56	124.7
		339	56	2.33	52.2	53.5	55.24	126.3
		339	58	2.42	52.5	54.0	55.76	127.5
		338	60	2.50	53.5	54.5	56.43	129.0
		338	61.5	2.56	54	55.2	57.15	130.6
		337	64.5	2.69	54.2	55.7	57.85	132.2
		337	66.5	2.77	55.5	56	58.15	132.9
		336	68	2.83	55.5	56.5	58.85	134.5
		335	69	2.88	55.7	57	59.55	136.1
		334	70	2.92	55.9	57.2	59.93	137.0
9.25.	334	334	71	2.96	56	57.5	60.25	137.7

(7) $$Z_{mw} = \frac{118\,\mathfrak{A}}{\frac{1440\,d}{S} + \frac{l}{a} + \frac{2\,l}{A}}$$ multipolar magnet wrought iron + cast iron poles.

(8) $$Z_{mc} = \frac{94\,\mathfrak{A}}{\frac{1800\,d}{S} + \frac{l}{a} + \frac{3\,l}{A}}$$ multipolar magnet cast iron

d = clearance (centrifu)
S = Magnetic surface
l = mean mag. dist: this armature.
a = mean area of armature (magnetic)
L = mean mag. dist. this magnet
a = mean area of magnet
$\mathfrak{A}$ = ampere turns

Allowing 4700 as the exciting power of each pair of coils; then $\frac{23500}{c}$ will be the number of turns on each limb if c be the current in amperes.

The Kapp formula applicable strictly speaking to Gramme armatures and fields of 10,000 lines to the sq cm or less, only are, reduced to cm. measurement :—

(1) $$Z_w = \frac{118\,\mathfrak{A}}{\frac{1440\,d}{S} + \frac{l}{a} + \frac{l}{A}}$$ (in wrought iron) of armature with cast iron pole

(2) $$Z_c = \frac{94\,\mathfrak{A}}{\frac{1800\,d}{S} + \frac{l}{a} + \frac{1.5\,l}{A}}$$ (in cast iron) magnet

(3) $Z_{mw} = 2\,Z_w$ nearly or

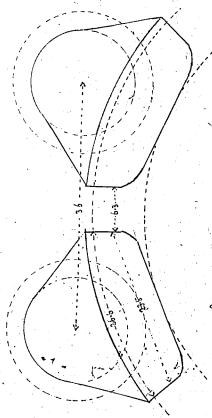
$$\frac{236\,\mathfrak{A}}{\frac{1440\,d}{S} + \frac{2l}{a} + \frac{2l}{A}}$$ (double magnets) in wrought iron with cast iron poles

(4) $$Z_{mc} = \frac{188\,\mathfrak{A}}{\frac{1800\,d}{S} + \frac{2l}{a} + \frac{1.5\,l}{A}}$$ (double magnets) in cast iron magnet

(5) $$Z_{mw} = \frac{236\,\mathfrak{A}}{\frac{1440\,d}{S} + \frac{2l}{a} + \frac{2l}{A}}$$ (double multipolar magnets) wrought iron cores + cast iron poles

$$= \frac{118\,\mathfrak{A}}{\frac{720\,d}{S} + \frac{l}{a} + \frac{l}{A}}$$

(6) $$Z_{mc} = \frac{188\,\mathfrak{A}}{\frac{1800\,d}{S} + \frac{2l}{a} + \frac{3\,l}{A}}$$ (double multipolar magnets) cast iron.



Projected Bipolar Dynamo.
½ Scale. Measured in Ohms.

Casting the Multipolar Dynamo afresh with 8 magnets instead of 12, we have the following diagram and calculations.

$d = 1$

$S = 26.6 \times 17.8 + 23 \times 7.5 = 473.5 + 172 = 645$

$l = 33$ (mean path)

$a = 112$

$\mathcal{L} = 80$

$\mathcal{A} = 143$ $\qquad \mathfrak{A} = 7600$ c.

Whence $Z = \dfrac{188 \times 7600\,c}{\dfrac{1800}{645} + \dfrac{66}{112} + \dfrac{240}{143}}$

$= \dfrac{1429000\,c}{2.8 + 1.2 + 1.7}$

$= \dfrac{1429000\,c}{5.7} = 3.4\,3\,7,000\,c$

10,000 lines to ap. cm. makes $Z = 1,430,000$

whence $= c = \dfrac{1430}{3.4\,3\,7} = 4.1$

and the gain in EMF is in ratio of 2.7 to 3.5 or nearly 30%.

The Pendulum Electro magnet
is made up as follows:—
The cores are 40·5 cms long and have
an average area of 46·57 cm.
so that the length of core is 81 @ 46·57
The yoke is a rectangular bar 7.4 × 7.4.
and the distance between the
core centres is 32·75 so that
if the poles were in direct connection
the length of yoke would be 65·5 @ 54·75
and at any time the mean distance of yoke
is (65·5 − d) at 54·75 area.

Assume the magnetic resistance of air
as $\frac{1}{4\pi}$ and let x be the magn: res: of the
iron. Then at 2·5 cms. I.P.D. the res: of
the air space may be regarded as 9(d)
while the res: of the remainder of the
circuit is $\frac{63}{54.75}x + \frac{81x}{46.57} = x(1.15 + 1.74) = 2.9x$ approx

The total number of lines formed at that time
was with 1905 ampere turns $2863 \times 46.57 = 133,330$
The wire being wound on a distance of 38·65 cms
and there being 1905 turns makes a mean
no of 4·929 turns per cm. the magnetic
field should therefore be approx. $\frac{4\pi}{10} \times 4.929$.
$= 61.94$
By Kapp's formula we would, have

$$I = \frac{119 \times 1905}{\frac{14400 \times 2.5}{46.57} + 2.9} = \frac{224,790}{10.6} = 21,200$$

Friday 8th June.

Two plates of zinc 28 × 29·1 or 819 sq. cms. and 0·0381 cm thick 1 sq ft 5 or 192·5 sq cms were immersed to about 46 sq. cms in Zn Sol. solution, this was composed of 5900 grammes of commercial zinc sulphate in 41,600 grammes of water. The current from the 110 volt Dynamo was passed through 2 lamp banks (16 16 lamps) at 114·50 giving 27 ampères.

1 ampère to 17 sq. cms.

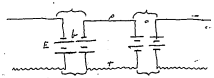
1 Gr. deposits 0·0001038 gr. H.
or 32·5 × 0·0001038 - Zn
= 0·00339 -
1 Coulomb - = 0·000339 - = 3·39 × 10^{-6}
3600 - - = 12·20 - Zn
4553·6 ampère hours = 370·0 1 lb. of Zn.
12·20
says 370. ampère hours per lb of Zn

∴ $\frac{370}{27}$ = 13·7 hours current for this current per lb.

1 Ampère hour gives 1·22 gr. Zn
$\frac{1000}{1.22}$ or 819·6 ampère hours give 1000 gr. Zn
at rate of 27 ampère 30 hours give 1000 -
- or 1 - - 33 - approx.

At 16.30 57 grammes had been deposited
= 1·8 ampères ought by calculation to have been 27

Added 4 more plates reducing the density of current to one fifth or 1 ampère to 85 sq cms
All set to work at 16.40



$$c = \frac{2E}{2b + r + p}$$

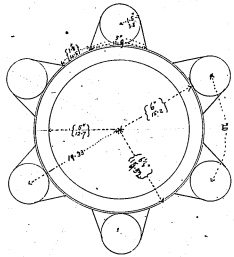
$$\mathcal{L}_c = \frac{236\,aJ}{\frac{1440\,d}{\frac{S}{2}} + \frac{l}{a} + \frac{l}{\frac{A}{2}}}$$

$$= \frac{118\,aJ}{\frac{1440\,d}{S} + \frac{l}{a} + \frac{l}{a}}$$

$$\mathcal{L}_c = \frac{94\,aJ}{\frac{1800\,d}{S} + \frac{l}{a} + \frac{1.5\,\mathcal{L}}{A}}$$

(4)

Required the exciting power for a converter similar to that on page 2 but a sexipolar instead of an octopolar machine



$d = \frac{1}{8}'' = 0.32$ cms.

$S = 144.0$ sq. in $= 11.9 \times 7.6 = 90.4$ sq. cms

$l = 4.5 + \frac{11.9}{4} = 7.5$

$a = 19$

$\mathcal{L} = 55$ cms

$A = \bigcirc = 22.7$ sq. cms.

$$363{,}000 = \frac{94\,aJ}{\frac{1800 \times 0.32}{90.4} + \frac{3.75}{19} + \frac{825}{45.4}}$$

$$= \frac{94\,aJ}{6.37 + 0.20 + 1.8} = \frac{94\,aJ}{8.37} = 11.2\,aJ.$$

$$\therefore aJ = \frac{363{,}000}{11.2} = 32{,}400 = 16{,}200 \text{ on each limb.}$$

The Edison no 2 Municipal has magnetos offering 1200 v, and presumably carrying $\frac{1000}{1200}$ or 0.77 ampères. The diameter of the wire is 0.028" and offers 0.01317 v per foot.
The energy consumed in heating this wire is 1000 × 0.77 or 770 Watts = $\frac{770}{4.2}$ = 183 g. cal per sec.
The radiating surface on these coils is 13⅝ × π × 20¾ × 6.45 sq. cms. = 57,200 so that there are $\frac{57200}{183}$ or 313 sq. cms. of radiating surface per g. cal per sec.

If now 1 ampère be employed in exciting the machine, the EMF in each of the 12 coils will be $\frac{110}{12}$ or 9.167 volts and the energy expended in heating each coil is 9.167 Watts or 2.183 g. cal. per sec. the radiating surface will be on one of these coils about 17.5 × 12.5 × 3.14 sq. cms. 687.5 sq. cms or $\frac{687.5}{2.183}$ = 315 nearly 10 times as much heat as in the Edison No 2.
Allowing 2.5 times as much heat as in the No 2. or $\frac{313}{2.5}$ = 125 sq. cms. per g. cal. the HF must be $\frac{687.5}{125}$ = 5.5 or 5.5 × 4.2 Watts = 23.1 Watts
$\frac{23.1}{9.167}$ = 0.25 or ¼ of an ampère. To carry this current allowing 200 c.m. to the ampère = 75 c.m. or need only be 0.009" no 32 B.W.G. but as that would be too expensive dry) No 26 0.018" in diam. might be used. To carry 0.25 ampère at 9.167 volts one must have 366.8 v or 366.8 × 31.39 feet = 11500 feet. Taking the mean turn at 12" or 1 foot would mean 11,510 turns or 2,880 Ampère turns only about one fifth of our desired magnetisation If No. 30 wire were adopted the diam. being 0.012, the length to be used would be less and – the at least Using no 23 wire whose diam = 0.025 the length would be 366.8 × 60.54 = 22,200 feet and the A.T would be (1 layer 200 turns = say 350 feet = 66 layers or 5.7" magnetizing turns) 18,600 = say

Rule: To find the no: of layers on a magnet core having given the winding space dimensions the length of the wire and its diameter.

Let L = the length of wire
d = its diameter (covered)
D = diameter of the ~~spool~~ core
t = the no of turns in a layer
l = the required no: of layers

Then

$$l = \frac{\sqrt{D^2 + \frac{4Ld}{\pi t}} - D}{2d}$$

The number of turns will be with no 23 wire as follows. Drum of 1st layer say 3.25". There will be .7 × 40 or 280 turns in each layer.

Let l = the no. of layers.
" t = " " turns in a layer
" D = " diameter of the 1st layer (bare)
" d " " " " wire covered.

Then $D + 2ld$ will be the external diameter. The mean diameter will be $D + ld$ and the total length L of wire will be

$$L = lt\pi(D + ld)$$

Here l is the unknown quantity.

$$l^2(t\pi d) + l(t\pi D) = L$$

$$\text{or } l^2 + l\frac{D}{d} = \frac{L}{t\pi d}$$

$$\therefore l^2 + l\frac{D}{d} + \left(\frac{D}{2d}\right)^2 = \frac{4Ld + D^2 t\pi}{4t\pi d^2}$$

$$\therefore l + \frac{D}{2d} = \pm\frac{\sqrt{D^2 t\pi + 4Ld}}{2d\sqrt{t\pi}}$$

$$l = \frac{\pm\sqrt{\frac{D^2 t\pi + 4Ld}{t\pi}} - D}{2d} = \frac{\pm\sqrt{D^2 + \frac{4Ld}{t\pi}} - D}{2d}$$

Here L = 22,200 × 12 = 266,400 inches
D = 3.25
d = say 0.028
t = 240 allowing covered diam = 0.028". 6 to" spaci.

$$\therefore l = \frac{\pm\sqrt{\left\{(3.25)^2 + \frac{0.112 \times 266{,}400}{240 \times 3.142}\right\}} - 3.25}{0.056}$$

$$\frac{\sqrt{10.56 + 29.57}}{0.056} = \sqrt{10.13} = 7.08$$

$$\frac{10.56 + 29.930}{7.53.8} = \frac{29.8400}{7.526} = 39.58$$

$$\sqrt{39.58} = 7.08 - 3.25 = 3.83 \div 0.056 = 68.$$

Mean Diam = 3.25 + 68 × 0.028 = 5.15" × π t = 5.15 × 749 = 3.83 × 68.

If only 6 magnet coils are used, and the heating is not excessive, the same winding might be employed and 0·5 ampere used. The ampere turns would then be $68 \times 240 \times 0{\cdot}5 = 16320 \times 0{\cdot}5 = 8{,}160$.

The Energy consumed in the coils will then be $11{\cdot}00 \times 0{\cdot}5 = 550$ Watts. about $\frac{6}{10}$ H.P.

Taking 8100 A T on each limb we have just 181,500 lines of force impressed on the wire of the armature by page 9 neglecting leakage.

The linear velocity of the armature at the circumference being $120 \times 30{\cdot}5$ cms per sec. $= 3660$ cms per sec: and the length of one turn being 7·6 cms. the area enclosed by the running wire is at the rate of 27,820 sq. cms. per sec:

The lines issuing from one pole are distributed over one sixth of the area of the ring rotation. That circum being $15{\cdot}2 \times 3{\cdot}14 = 47{\cdot}73 \times 7{\cdot}6 = 362{\cdot}8$ sq. cms. so that the average field of force is $6 \times \frac{181{,}500}{362{\cdot}5} = 3000{\cdot}$. The no: of lines enclosed per sec: by one turn of wire is thus $3000 \times 27{,}820 = 80{,}410{,}00 = \frac{100}{10^8}$ ~~$\frac{1}{10^8}$~~ to the volt.

The number to give 112 volts will be ~~124~~ $\times 112 =$ ~~13900~~ turns on each $\frac{1}{16}$th of the circumference say 1400 or 8400 ~~turns~~ altogether.

Infact into 3" 1400 turns have to be coiled.

Allowing ·50 ampere to be the output of the machine the armature at 150 ⊥ the amp. $= \frac{7500}{150}$ would be about no 20 wire 0·085" diam say covered 0·09" the would mean ~~to coil the~~ allowing in 15 layers of 75 turns

The length of wire would be approximately 100 feet on each segment and the res: of this would be 0·814 say 0·900 Rot or 0·150 for the internal res: of the armature. This would mean a loss of 50 × 50 × 0·15 = 375 Watts lost in heating the armature.

Set up an Electrical Accumulator Company's storage cell which arrived in the morning packed dry:—

It was composed of 15 leaden plates 23·5 × 25 cms. thus exposing 8,224 cq cms. on each plate multiplied. The whole 15 plates and attachment weighed 82lbs or 37,200 gms. On ~~pour~~ immersing them completely in dilute H_2SO_4 sp. grav. 1·150 the battery gave a current of 23 amperes through the small H&B ammeter + 15 through the large one. Kept it at work on 2·3 amperes from 10 o'clock.

The energy that has to be taken from the machine considered as a motor is 110 × 50 or 5500 Watts add to this the Watts in the dynamo and we have to provide for 5820 Watts add to this 10% for friction &c. and we have a total of 6500 Watts to be furnished by the motor. This must be the product of the EMF of ~~at the motor~~ and the current it conveys. Assuming that 1100 will be the E.M.F. then 5·9 amperes must be carried. Or from the equation $W = \left(\frac{E-e}{r}\right)e$ we have W being $6500 = \left(\frac{1100-e}{r}\right)e$ we are free to chose the terms e and r. $\therefore 6500r = 1100e - e^2$

$\therefore e^2 - 1100e = -6500r$

$\therefore e^2 - 1100e + 550^2 = -6500r + 302500$

$e^2 - 1100e = \sqrt{6500(47 + 46{\cdot}5)}$

$e - 550 = 81\sqrt{47+46{\cdot}5}$

$e = 550 + 81\sqrt{47+46{\cdot}5}$

Assuming t to be say 2.50 makes the armature radial part 7 and the counter e.m.f 1067 volts. Each segment would then offer a res: of 15 and the problem is to find a winding of 15 that shall offer an EMF of 1070 volts. at the rate of rotation above indicated. Each turn generates 0.8 volts so that there must be 1.24 X 1070 turns = 1327 Each turn is about 8' long or 0.67 feet and 1327 turns will be over 1327 X 0.67 say over 889 feet or 900 feet. This 900 feet must offer only 15 or 0.0167 per foot or no 23. wire. The diam: being 0.025" there is room for only 120 turns so that this wire is out of the question In fact allowing 3/8 of an inch for wire winding depth on the ring we know that $\frac{0.1}{d} \times \frac{3}{8}$ must exceed 1330. that is $d = \sqrt{\frac{0.3}{1330}} = \sqrt{0.00022556} = 0.015$.

that being our limit, we may take with greater safety the 0.013 wire no 29. whose res: is 0.061 ω per foot. Every turn of this wire introduces at least 0.061 X 0.67 ω and every volt 0.061 X 0.67 X 1.24 ω = 0.05024 ω. This however must be divided by 6 for the whole machine or 0.00837 ω for every volt. Now in the expression $\frac{e\,(E-e)}{r} = 6500$ we have

$$\frac{e\,(E-e)}{0.00837e} = 6500$$

or $E - e = 6500 \times 0.00837 = 54.42$ $\quad + r = 1045.6 \times 0.0083 = 8.75$

or $e = 1100 - 54.4 = 1045.6$ volts

The no: of turns must then be $1045.6 \times 1.24 = 1296$ say 1300. The dimensions of the mean turn will be $2(1.80 + 3.80) = 8.4'$ and the turns in a layer being 200 we have 1680' or 140 feet for the length of one layer. ~~The total length being 22.5 X 140 = 3150 feet.~~ We must then have 7 layers = 1400 turns and 980 feet. $7 \times 0.015 = 0.1'$. Res. $61 \div 6 = 10$ ω The current flowing will be assumed $\frac{54.44}{10} = 5.44$ amps or 0.44 amp in each segment

Revision of work as check:

Required the winding of the armature and field magnets of a converter working between 1100 and 112 volts at a circumferential velocity of 120 feet per sec: allowing 6 magnets and cores round the periphery of the armature whose ring shall be 10" and 12" int. + ext. diam. with ⅛" clearance, as a matter of necessity it will be an entefer of ⅞", the internal and external diameter being reduced by ⅛" to allow of bare winding. The machine is designed primarily to supply 50 amperes at a commercial output of 5600 Watts.

The magnet core will be wound with No 23 cotton-covered wire. 0.025" diam: commencing as close to the core as insulation will allow the diam of the first layer being taken as 3¼". There should be in the interflange of 6¾", 240 turns and 68 layers making 16,320 turns in all. The mean layer would have a diameter of 5.15" the outer diameter would be 6.95" or 7" and the total length of wire on each magnet would be 22,000 feet weighing 420 lbs. The total weight on the 6 cores would be 252 lbs: @ 76 c = $191.50

Each pair of cores will supply 8160 ampere turns at half an ampere of current because the res: of no 23 wire being 16.517 ω per 1000 ft the res: of each limb would be 22.2 × 16.517 = 366.7 ω and the 6 limbs together would offer 2200 ω or give 0.5 ampere to 1100 volts. The cir: mils of the wire being 625 allows 1250 cir: mils to the ampere and the radiating surface is 62.5 sq. cms. to the Heat Unit (gram Calorie) per sec: The energy expended in heating the coils will be (1100 × 500 Watts)

The ampere turns from any pair of cores being 16,320, we should expect from Hopkinson's formula modified to suit the multipolar machine a total induction of

$$\frac{94 \times 16{,}320}{\frac{1800\,d}{S} + \frac{l}{2a} + \frac{1.5L}{A}}$$

where d is the entrefer say 0.32 cm. (⅛")

S - - Inductive surface on the ~~half~~ polar-face or 90.4 sq. cms.

l - - 7.5 cms. of line dist. in armature

a - - area of induction in armature = 19.90

L - - Mean length the magnets = 55 cm

A - - - area - - = 45.4.

$$\therefore \text{Induction} = \frac{94 \times 16\,320}{6.37 + 0.2 + 1.8} = 181{,}500$$

= nearly 11,000 to the sq. cm.

This magnetisation has inductive influence over one sixth of the whole periphery of the armature or $\frac{30.4 \times 3.14 \times 7.6}{6} = 120.9$ sq. cms. so that the average field will be $\frac{181{,}500}{120.9}$ or 1,500 lines to the sq. cm.

The no. of lines enclosed per sec. by one turn of wire will be at the rate of $1500 \times 7.6 \times 120 \times 20.5 = 41.7 \times 10^6$ or the EMF from each turn will be $\frac{10^8}{10^8} \cdot \frac{41.7}{10^6} = 0.417$ volts. The number required to give one volt = 2.4 and for 112 volt 268.8 turns will be required on each segment of the armature say 270 or 1620 turns altogether in the secondary circuit. So that 270 turns must be wound within 3" allowing insulating space. Assuming that 50 amperes will be the output of the machine ~~the~~ and taking the circ. mil at 150 to the ampere we have

$\frac{50 \times 150}{6} = 1250$ as the circ. mils of each wire or no 20 wire 0.035" in diam say 0.04" insul. 75 turns of this would make a layer and 16 layers making 800 turns and a thickness of 0.16" = $\frac{1}{6}$" of wire if wound carefully. The length of this secondary wire would be approximately 214 feet and the res: of this at 0.00816 is 1.8ω cold or 2.0ω hot. The total res: of the machine would then be 0.23ω and the energy lost in heating the armature at full load would be $50 \times 50 \times 0.23 = 825$ Watts. The total length of secondary wire on the armature would be 1300 feet. The E.D. at full load $= 112 - 0.23 \times 50 = 95.5$ terminals during

The energy that has to be taken from the machine considered as a motor is 5500 Watts although only 4775 would be yielded externally on the above figures. Say that including the waste in the secondary circuit and the friction res: of the motor 6500 Watts must be absorbed by it then we know that

$$6500 = (1100 - e)\,e$$

Our limit of winding is such that $\frac{3}{d} \times \frac{0.16}{d} =$ No of turns in a segment.

Now if our efficiency is to be 85% a fair value then $e = 935$ say 940 volts and we must provide 2.4×940 or 2256 turns on each segment $\therefore \frac{0.48}{2256} = d = \sqrt{0.0002128} = 0.0146$ allowing for insulation say no 23 wire 0.013. The mean turn will be 8.6" and the No of turns in a layer will be 205 say 200 so that we shall have 12 layers or 2400 turns and a length on each segment of 1720 feet or 11,440 feet in all.

The resistance of this wire being. 0.0611 ω per foot will be 105.1 ω cold or say about 120 ω hot. So that the total res: in the primary cct. would be 20 ω. at normal speed therefore while giving a counter EMF of 950 volts the current flowing through the primary cct. would be $\frac{1100-950}{20} = \frac{150}{20} = 7.5$ amperes or 1.25 ampere through each ~~fire~~ segment. The circ. mils of the wire being 169 allows 135 circ. mils to the ampere, and if this is too great a current density the output must be reduced because at 1100 volts in order to consume 6500 Watts there must be a current of nearly 6 amperes without taking loss by conversion into account. Consequently the current flowing in each wire cannot be much below 1.25 amperes and if the circ: mils be increased the counter EMF will be reduced and a larger current will pass through.

Consequently we have at full load

Expended in Machine	Derived from Machine
In magnet coil	550 Watts
~~Heating~~ the primary cct	1120 "
Heating the secondary cct	825 "
Friction &c.	250 "
Delivery	~~5420~~ "
Total	8170

5420
~~70~~
66

$$\frac{2cr^2}{(r^2+x^2)^{\frac{3}{2}}} = H.$$

$$c = \frac{H\,(r^2+x^2)^{\frac{3}{2}}}{2r^2}$$

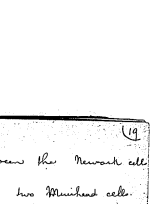
$$= 0.002644\,(x^2+36)^{\frac{3}{2}}$$

where c = current in abs. measure
r = radius ring
x = distance from centre.
H = horizontal component = 0.19.

Tested the 5 standard cells.
The greatest difference between the Newark cells is 0.0002 volt
The difference between the two Minehead cells is also about 0.0002 volt
The difference between the Newark + Minehead cells at the same temp: is less than 0.0005 volt

Test of Edison system 9. 6. 88

All houses cut off



Tried the maximum load on the multiple dynamo. The maximum indicated current on the spiral ammeter was 440 + 220 = 660. Used the single ring ampere meter whose mean diam is 9.85 + 14.0 / 2 = 11.925 and whose mean radius is consequently 6. The highest reading reached on its scale giving 45° deflection was 29.4 corresponding to 762 amperes. The volts were about 100 (indicating) about 100 H.P. The main belt refused to transmit this full power. The charging current for the full (24 magnets in multiple arc) was about 75 amperes.

The range of the long ampere meter is up to 18,000 amperes in this vicinity H being 0.19.

$$M = \frac{r^2}{2} H \tan\theta$$

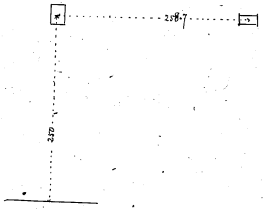
$$= \frac{(2587)^2 \times 10^4 \times 0.189 \times 5}{500}$$

$$= 17.3126 \times 0.189 \; 5 \times 10^4$$

$$= 3.4628 \times 0.189 \; 5 \times 10^4$$

$$= .6545 \times 10^4 \; 5$$

$$= 6545 \; 5$$



Four series of observations were taken
1st without any core
2nd with Fe Br in glass tube
3rd " Cast iron filings in paraffine wax
4th

No	Range in ch	Res: in ch	Shock Tap.	Current in abs. ch	Calculated Magnet Moment	Observed Magnetomet. B	Calculated Magnetic Field B	Magnetic Field in Lines NEW				
1	0	∞	0	0	0	0	0	0				
2	17	820	0·03	0·0157	1127	0·19	1246	23·1				
3	-		0·05	0·0262	1978	0·29	1901	38·5				
4	-		0·10	0·0524	3756	0·62	4065	77·1				
5	-		0·20	0·1048	7512	1·27	8326	154·2				
6	-		0·30	0·1572	11269	1·89	12391	231·3				
7	-		0·40	0·2096	15025	2·53	16587	308·3				
8	-		0·50	0·2621	18781	3·19	21,360	385·4				
9			0·60	0·3145	22537	3·83	25110	462·5				
10			0·70	0·3669	26293	4·42	28.978	539·6				
11			0·80	0·4193	30050	5·19	34026	616·7				
12			0·90	0·4717	33806	5·85	38353	693·8				
13			1·00	0·5241	37562	6·55	43139	770·9				
14			1·20	0·6289	45074	7·765	50908	925·0				
15			1·40	0·7337	52587	8·99	58939	1079·2				
16			1·58	0·8281	59348	10·67	67497	1218·0				
17			1·72	0·9015	64607	10·86	73478	1325·9				
18												
19												

No. Reading	Magnet in Coil	Pier in coil	Shunt Ohms	Current	Field H	Magnetic Moment S.	Moment of Coil rotor.	Moment of coil only	Moment of armatu	Magnetisation I	K	μ	Induction B
1	17	/	0.03	0.0157	23.1	0.2116	14403	124657	157				
2	"		0.05	0.0262	38.5	0.330	21664	19017	263				
3	"		0.10	0.0524	77.1	0.667	42373	40665	308				
4	"		0.2	0.1048	154.2	1.294	84484	83226	158				
5	"		0.3	0.1572	231.3	1.846	121103	123391	−288				
6	"		0.4	0.2096	308.3	2.550	167118	165587	131				
7	"		0.5	0.2621	385.4	3.223	211130	213360	−230				
8	"		0.6	0.3145	462.5	3.823	250664	251100	−46				
9	"		0.7	0.3669	539.6	4.466	291148	289978	170				
10	"		0.8	0.4193	616.7	5.154	337790	341026	−236				
11	"		0.9	0.4717	693.8	5.794	379786	383353	−347				
12	"		1.0	0.5241	770.9	6.344	422444	423139	−695				
13	"		1.2	0.6289	925.0	7.320	501613	509668	−295				
14	"		1.4	0.73375	1079.2	9.198	603203	589939	+13264				
15	"		1.58	0.8281	1218.	10.120	663148	674497	−1149				
16	"		1.72	0.9015	1325.9	11.095	727440	734478	−738				

Friday 14th June.

Took off accumulator cell after 95 hours continuous charging from a 5 cell Lalande battery, the charging current having in that time fallen from 5 to 0 ampères. Taking the average current at 2 ampères would give a total of 190 ampère hours = 190 × 3600 coulombs = 684,000 coulombs = 153 g. 000 Joules. The sp. g. is 1·075. The Lalande battery gives 2 amps: through the small H.B. ammeter.

The accumulator gives 2·6 ampères through the same ampèremeter.

Set the 3 Robert Brewodt cells to work as follows:—

Each cell containing 2 zinc plates each weighing 4 lbs = 1814 grammes and exposing (35·6 × 15·1) thickness (0·18 cm) = 538 sq. cms. The total weight of zinc in each cell is 3628 g. and total active area 2152 sq. cms.

Also 3 carbon plates weighing 2 lbs = 907 g. and their dimensions (40 × 17·4) thickness (0·327 cm) the total area would be about 700 sq. cms. on each side of plate and the active surface varies but would be about 60% of this or say 420 sq. cms. The total active carbon area in each cell is thus about 1680 sq. cms.

The active liquid in each cell is about 6800 c.c. and salt water solution is poured to within an inch and a half of the zinc tops, say about 7000 c.c. so that the total solution may be about 8500 c.c.

Date	Time	Hours at work	EMF	Roberts & Bakewort ~~E~~	~~I.R.~~	Tube Work Date	Alle Work Date	EMF	E.	I.R.
15.6.88	8.15	0	2.128	3.756	0.066					
	9.15	0.5	2.098	4.056	0.017					
	10.00	1	2.066	4.032	0.012					
	11.00	2	2.072	4.024	0.015					
16.6	8.30	24	2.032	3.884	0.023					
	15.30	31	2.042	3.886	0.025					
17.6	8.40	55	1.978	3.776	0.047					
18.6	8.30	71½	1.922	3.800	0.005					
14.6.88	8.0	55	1.878	2.130	0.104					
	10.0	105	1.078	1.776	0.108					
20.6.88	8.0	119	0.618	1.016	0.108					
	12.0	124	0.594	0.982	0.101					
	18.00	129	0.476	0.922	0.105					
21.6.88	8.0	143	0.473	0.816	0.104					
	18.00	153	0.424	0.776	0.095					
22.6.88	8.0	167	0.402	0.764	0.081					
	10.0	171	0.470							
13.6.88	8.00	0	2.096	3.700	0.066					
	9.15	0.5	2.062	3.800	0.070					
	12.00	3	1.995	3.476	0.074					
	17.30	8	2.006	3.496	0.061					
14.6	8.00	24	1.946	3.384	0.080					
	15.30	31	1.962	3.200	0.105					
16.6.88	8.30	55	1.826	3.124	0.084					
18.6	8.30	71½	1.700	2.860	0.094					
19.6.88	8.0	95	1.197	2.036	0.074					
	10.0	105	1.036	1.436	0.073					
20.6.88	8.0	119	0.595	1.022	0.083					
	12.0	124	0.577	1.000	0.072					
	18.0	129	0.528	0.996	0.080					
21.6.88	8.0	143	0.478	0.948	0.063					
	18.0	153	0.460	0.848	0.062					
22.6.88	8.0	167	0.461	0.800	0.076					
	10.0	171	0.442							
13.6.88	9.00	0	2.110	3.796	0.056					
	9.15	0.5	2.074	3.610	0.060					
14.6.88	7.00	2	2.010	3.536	0.068					
	7.00	8	2.009	3.528	0.069					
16.6.	8.15	24	1.966	3.408	0.077					
	15.30	31	1.965	3.372	0.073					
17.6.88	8.0	55	1.844	3.152	0.085					
18.6.88	8.30	71½	1.800	2.800	0.111					
19.6.88	8.0	95	1.142	1.948	0.087					
	10.0	105	0.748	1.576	0.088					
20.6.88	8.0	119	0.580	0.992	0.094					
	12.0	124	0.580	0.944	0.095					
	18.0	129	0.516	0.896	0.075					
21.6.88	8.0	143	0.452	0.820	0.071					
	18.0	153	0.480	0.800	0.080					
22.6.88	8.0	167	0.470	0.714	0.073					
	10.0	171	0.442							

These Roberts cells were charged on the 11th June and were set to work at 8.45 on the 15th June. They then were discharged continually through 0.5Ω of platinoid wire 0.084 cm. (0.033") in diam. 6 strands in multiple arc: The Potentiometer reading were

Time	Hours at work	Cell no.	P.D.	EMF	E.	I.R.
15.6.88 8.45	0	1	1.878	2.128	3.756	0.066
		2	1.850	2.096	3.700	0.066
		3	1.898	2.110	3.796	0.056
16.6.88	23	1	2.016	2.066	4.032	0.012
		2	1.998	1.996	3.476	0.074
		3	1.768	2.010	3.536	0.068
17.6.88	8	1	2.022	2.072	4.044	0.015
		2	1.748	2.006	3.496	0.061
		3	1.764	2.008	3.528	0.069
17.6.88 8.15	23½	1	1.942	2.032	3.884	0.023
		2	1.693	1.964	3.386	0.080
		3	1.703	1.966	3.406	0.077
12.6.88 7.15	8½	1	2.028	2.098	4.056	0.017
		2	1.770	2.020	3.540	0.070
		3	1.855	2.074	3.610	0.060
16.6.88 15.30	31	1	1.943	2.042	3.886	0.025
		2	1.620	1.962	3.240	0.105
		3	1.686	1.965	3.372	0.073
17.6.88 16.0	55	1	1.576	1.844	3.152	0.085
		2	1.562	1.826	3.124	0.084
		3	1.888	1.976	3.776	0.047
18.6.88 8.30	71½	1	1.900	1.922	3.800	0.005
		2	1.430	1.700	2.860	0.094
		3	1.400	1.713	2.800	0.111

Saturday 15th June

The accumulator cell failed to work on the pattern motor after 24 hours running. The estimated current during that time being 200 ampères the total energy expended would be:

200 × 24 × 3600 = 17,280,000 Joules.

A ground on one of the mains in the Bunkie branch of the Edison lighting circuit was found to be in a length of pipe just inside the field on Bunkie's premises. It was the first tube clear of the fence or the third from the box at the Eastern side of the road where it makes a 45° crossing. The tube was removed and replaced. The pressure wires are separate and disconnected in every length between the road box above mentioned and the 5th box in the field or rather during that is to say for 5 lengths.

Took following observations for the determination of effect of mass in core of magnet with the same winding.

Wound 46 metres of cotton-covered wire 0·027" in 3145 turns on the cylinder of cast iron used in the ordinary permeability experiments the dimensions of which are (6" × 1¼ diam.) or 15·2 and 31·75 cm.

Also wound 46 metres of cotton-covered wire 228 turns on the cylinder (6" × 2⅞) or 15·2 × 6·27

The calculated ratio should have been $\frac{3145 \cdot 5}{228 \cdot 6} = 13$

A series of 5 currents was sent through each coil and core and the magnetometer readings taken:-

Coil:	Bench D:	G:	Mag. Defln.
Large.	0·251		0·26
Small.			0·21
Large	0·100		0·51
Small			0·475
Large	0·299		1·545
Small			1·490
Large	0·500		2·60
Small			2·55
Large	0·800		4·21
Small			4·13.

The ~~calculated~~ ratio of the magnetic forces is as follows:—

The magnetic field in a solenoid is $\frac{4\pi Nc}{l}$ where N is the total no: of turns, l is the length and c is the current in abs: measure.

The permeability μ would cause an induction of $\frac{4\pi\mu Nc}{l}$ = induction per sq. cm. over a given area & the induction would be $\frac{4\pi\mu Nca}{l}$

Now assuming that the vol: of the coil is the same as that of the core, the total induction in the two cores would be as 314·5 : 456 = 1·45.

The moment of the large coil + l × 4π ~~same~~ = Induction (total) La and × $\frac{4\pi}{l}$ = f

			leads	mains
In Burke House				
Res: of + and −		1.504	0.7225	0.4385
- - + " 0		1.573	0.754	0.789
- - − " 0		1.572	0.782	0.790
			2.0175	
			1.0088	
		+ Main	0.2188	
		− "	0.2198	
		0 "	0.5703	
Of these as far as the EB		+	0.128	
		−	0.128	
		0	0.322	
Leaving from E.B. to Burke		+	0.091	
		−	0.092	
		0	0.248	

Taking the res: of the mains at 7.15×10^{-5} this would make the distance from E.B. to Burke's House 1280 feet. = 427 yds.

Tests for localization of Ground in Burke mains: 27

Monday 18th June.

Res: of leads to terminal board				0.075
" - these and leads to E.R.				Res leads
+ −	0.7225	+ =	0.3622	0.325
+ 0	0.754	−	0.3602	0.325
− 0	0.782	0 =	0.4227	0.365
	2.2885			
	1.1442			

Res: of cct composed as follows:

Leads to E.R. + and −	0.7225
To Burke's house leads joined these + and −	1.1610
	0.4385
Res: of mains to E.B. 2 × 0.1275	0.2550
- - - from EB to Burke's.	0.1835

Barley Loop. 1000/100 added Res: to − 0.198
whence D. of F = 0.499 " from bridge
Lead to E = 0.360
D. of F. from ER 0.129

Barley Loop 1000/100 Added Res: to 0.154
Whence D of F = 0.496 " from bridge
lead to F 0.360
D. of F from ER 0.136

Barley loop - 1000/10 Added Res: to − 65.79
Whence D of F = 0.498 " from bridge
lead to ER. 0.360
D. of F from " = 0.138 " "

Taking the distance from the E.R. at 0.138
and the leads to the E.B. at 0.1275
Makes dist: of fault from EB 0.0105

If the mains have a res: of 7.15×10^{-5} this corresponds to a distance of 147 feet say ¼ length of pipe from E.B.

Tests for comparison of Clark standard cells.

1·43 volts gave 121 divs: thro the astatic 5th Lord Kelvin (at Temp 19·5) and 52 of Carbon res:
Under these circumstances 1 div. corresponds to 0·00002 volt
(Assuming) that cell no 1 of the Newark set was 1·4300

then		2	1·42994
"		3	1·43000
"	English	1	1·43044
		2	1·4303

The difference between the Newark cells is within 0·00012 volt,
" " " " English " " 0·00010 "
The greatest observed deflection has been 50 divs: (probably) due to temp: diff only but this would mean 0·001 volt or 1 part in 1430

The mean difference may be fairly placed at 20 divs = 0·0004 volt or 1 part in 3575 = 0·028%

Note by Griffiths from my pencil [illegible] [illegible] [illegible]

Hydrometer [illegible] by [illegible]

Mass 490 · Density 2·32.

Observed Weight Deflection	Required Weight Deflection	C. required in the mass	Observed Weight Deflection	Corrected Deflection for C.	C	K	Moment of Coil + core	Moment of Coil	Moment of core	I	κ	μ	L
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0·0305	0·03	0·0157	0·605	0·595	23·1	3901	1246	2655	12·96	0·561	9·05	186·0
0·050	0·05	0·0262	0·80	0·780	38·8	5114	1901	3213	15·68	[illegible]	6·115	235·4
0·0985	0·10	0·0524	1·19	1·167	77·1	7651	4065	3586	17·50	0·229	3·853	297·1
0·202	0·20	0·1048	2·20	2·119	154·2	13892	8324	5566	27·17	0·176	3·212	405·3
0·302	0·3	0·1572	3·10	3·00	231·3	19668	12391	7277	35·52	0·154	2·930	677·7
0·40	0·4	0·2096	3·91	3·81	308·3	24979	16587	8392	40·96	0·153	2·670	823·2
0·50	0·5	0·2621	4·25	4·13	385·4	27077	21360	5717	27·91	0·072	1·910	734·1
0·60	0·6	0·3145	5·6	5·56	462·5	35796	25110	10686	52·16	0·113	2·417	1117·9
0·697	0·7	0·3669	6·42	6·287	539·6	41219	28978	12240	59·75	0·1107	2·391	1290·2
0·80	0·8	0·4193	7·295	7·115	616·7	46647	34026	12621	61·56	0·0998	2·254	1390·0
0·89	0·9	0·4717	8·04	7·929	693·8	51983	38353	13630	66·53	0·0957	2·205	1529·8
0·992	1·0	0·5241	8·85	8·679	770·9	56900	43129	13761	67·17	0·0871	2·095	1615·0
1·185	1·2	0·6289	10·33	10·187	925·0	66787	50908	15879	77·51	0·0838	2·053	1899·0
1·41	1·4	0·7338	12·12	11·767	1079·2	77146	58929	18207	88·88	0·0834	2·048	2210·2
1·585	1·58	0·8281	13·5	13·18	1218·	86409	67497	18912	92·32	0·0757	1·953	2378·8
1·77	1·72	0·9015	14·89	14·23	1326.	93293	73478	19815	96·72	0·0730	1·917	2541·8

6

Cast iron filings in glass tube with paraffin wax. Volume 1865 mm³
Density 2·04

Observed Hook Deflec.	Hook Deflec: required	Ib: in abs: measure	Observed Mag. Deflec.	Corrected M.D. deflec.	Moment of Coil raw	Moment of Coil	Moment of Core	I	H	k	μ	L
0	0	0	0	0	0	0	0	0	0	0	0	0
0·027	0·030	0·0157	0·535	0·534	3894	1246	26148	14·23	23·1	0·616	8·741	191·7
0·050	0·05	0·0262	0·750	0·737	4917	1907	3076	16·21	38·5	0·421	6·290	242·2
0·10	0·1	0·05244	1·25	1·25	8195	4065	4130	22·20	77·1	0·288	4·619	356·1
0·198	0·2	0·1048	2·21	2·23	14620	8324	6304	33·89	154·2	0·2198	3·762	580·1
0·298	0·3	0·1572	3·2	3·22	21,111	12,391	8720	46·88	231·3	0·2027	3·547	824·4
0·398	0·4	0·2096	4·185	4·206	27,875	16,587	10988	59·07	308·3	0·1916	3·408	1050·7
0·500	0·5	0·2621	5·11	5·11	33,502	21,360	12142	65·28	385·4	0·1941	3·129	1205·9
0·597	0·6	0·3145	6·02	6·05	39,664	25,110	14554	78·25	462·5	0·1692	3·126	1445·8
0·700	0·7	0·3669	6·985	6·98	45,762	28,978	16784	90·24	539·6	0·1672	3·101	1673·3
0·798	0·8	0·4193	7·835	7·853	51,485	34,026	17459	93·86	616·7	0·1521	2·911	1795·2
0·902	0·9	0·4717	8·8	8·78	57,563	38,353	19210	103·27	693·8	0·1488	2·870	1991·2
1·020	1·0	0·5241	9·7	9·67	63,397	43,139	20258	108·91	770·9	0·1413	2·776	2140·0
1·185	1·2	0·6289	11·24	11·38	74,608	50,908	23700	127·42	925·0	0·1377	2·730	2525·
1·400	1·4	0·7338	13·05	13·05	85,557	58,939	26618	143·11	1079·2	0·1326	2·666	2871
1·580	1·58	0·8281	14·8	14·8	97,030	67,497	29,533	158·78	1218·0	0·1304	2·639	3214
1·660	1·72	0·9015	15·32	15·87	104,045	73,478	30,567	164·34	1325·9	0·1239	2·557	3390
0												

Remarks. Show the [illegible] Volume 198·3 Density 2·77
Mass 550.

Block Depth observed	Block Depth required	δ in abs. mean	Observed Magnetic Deflen.	Corrected Magnetic Deflen.	Moment of Coil tare	Moment of Coil	Moment of Core	I	H	k	μ	L
0	0	0	0	0	0	0	0	0	0	0	0	0
0·03	0·03	0·0157	0·49	0·48	3147	1246	1901	9·59	23·1	0·415	6·215	143·6
0·05	0·05	0·0262	0·71	0·70	4589	1901	2688	13·55	38·5	0·352	5·423	208·8
0·101	0·1	0·0524	1·3	1·16	7605	4065	3540	17·85	77·1	0·232	3·909	301·4
0·204	0·2	0·1048	2·4	2·33	15276	8326	6950	35·04	154·2	0·227	3·853	594·1
0·296	0·3	0·1572	3·39	3·405	22322	12391	9933	50·08	231·3	0·217	3·721	860·7
0·394	0·4	0·2096	4·39	4·426	29017	16557	12430	62·67	308·3	0·2033	3·555	1096·0
0·492	0·5	0·2621	5·32	5·365	35173	21360	13813	69·65	385·4	0·1807	3·271	1280·6
0·590	0·6	0·3145	6·35	6·368	41749	25110	16639	83·90	462·5	0·1814	3·280	1517·0
~~0·688~~	0·7	0·3669	7·3	7·292	47807	28978	18829	94·94	539·6	0·1759	3·210	1732·1
0·800	0·8	0·4193	8·29	8·174	53590	34026	19564	98·64	616·7	0·1599	3·009	1855·7
0·902	0·9	0·4717	9·13	9·040	59267	38353	20914	105·45	693·8	0·1520	2·910	2019
0·992	1·0	0·5241	9·95	9·930	65102	43139	22063	111·24	770·9	0·1443	2·813	2169
1·190	1·2	0·6289	11·35	11·870	75854	50908	24946	125·78	925·0	0·1359	2·708	2505
1·385	1·4	0·7338	13·39	13·050	85754	58939	26815	135·20	1079·2	0·1253	2·574	2778
1·580	1·58	0·8281	14·55	14·560	95457	67497	27960	140·99	1218·	0·1158	2·455	2990
1·785	1·72	0·9015	16·22	15·520	101882	73478	28404	143·21	1326·	0·1080	2·357	3125
~~1·785~~												

(2)

Coil set at greater dist: from needle for min cur

Obd. Obsd. Deflection	Required Obsd.	Current in abs: units.	H.	Observed Magnetic Diff.	Corrected Magnetic Diff.	Moment from this Deflec.	of Mag. Bar	Calculated from Diff. Page 31
0·031	0·03	0·0157	23·1	0·075	0·0823	1395	12477	12469
0·0495	0·05	0·0262	38·5	0·115	0·1162	1969	1878	1901
0·102	0·10	0·0524	77·1	0·22	0·2255	3821	3756	10265
0·206	0·20	0·1048	154·2	0·449	0·4495	8389	7512	8326
0·299	0·30	0·1572	231·3	0·715	0·732	12405	11249	12391
0·400	0·40	0·2096	308·3	0·970	1·00	16947	15225	16587
0·508	0·50	0·2621	385·4	1·220	1·25	21183	19291	21360
0·598	0·60	0·3145	462·5	1·46	1·505	25505	22537	25110
0·698	0·70	0·3669	539·6	1·72	1·775	30080	26493	28978
0·800	0·80	0·4193	616·7	2·00	2·05	34741	30050	34028
0·900	0·90	0·4717	693·8	2·23	2·29	38808	33906	38357
1·00	1·00	0·5241	770·9	2·48	2·56	43386	37762	43139
1·190	1·20	0·6289	925·0	2·91	3·005	50,925	45070	50908
1·440	1·40	0·7338	1079·2	3·33	3·50	59,318	52587	59899
1·60	1·58	0·8291	1218·0	4·06	4·088	69,278	59,948	67147
1·83	1·72	0·9015	1325·9	4·58	4·38	76,227	66,607	73478

Obd. Obsd. Deflection	Required Obsd. Deflection	Current in abs. units	Observed Magnetic Diff.	Corrected Magnetic Diff.	Moment of Bar + rem	Moment of Coil	Moment of Bar + rem	Moment of Coil	I	H	K	μ	L
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0·03	0·0157	0·35	0·35	0·35	17311	13395	15316	14142	23·1	23·1	0·8949	11·67	2646
0·05	0·0262	0·63	0·63	0·63	7387	1969	6396	8897	38·5	38·5	0·5798	8·51	327·7
0·10	0·0524	0·61	0·97	1·03	1·02	3821	3522	12·4·93	77·1	77·1	0·253	5·444	449·3
0·20	0·1048	1·08	1·02	1·36	1·363	8389	8389	16947	154·2	154·2	0·200	4·14	658
0·30	0·1572	1·72	2·10	2·40	2·73	12405	16947	21183	231·3	231·3	0·169	3·12	811·5
0·40	0·2096	2·10	2·73	3·085	3·40	16947	21183	25505	308·3	308·3	0·156	2·96	1044·8
0·50	0·2621	2·48	3·40	3·88	4·38	21183	25505	30080	385·4	385·4	0·131	2·52	1360
0·60	0·3145	2·91	3·88	4·38	4·88	25505	30080	34741	462·5	462·5	0·116	2·46	1512
0·70	0·3669	3·33	4·38	4·88	5·39	30080	34741	38808	539·6	539·6	0·111	2·39	1657
0·80	0·4193	3·83	4·88	5·39	5·92	34741	38808	43386	616·7	616·7	0·108	2·36	1820
0·90	0·4717	4·32	5·39	5·92	6·45	38808	43386	50925	693·8	693·8	0·104	2·31	2137
1·00	0·5241	4·84	5·92	6·45	7·00	43386	50925	59318	770·9	770·9	0·1027	2·29	2471
1·20	0·6289	5·90	7·00	7·55	8·15	50925	59318	69278	925·0	925·0	0·0977	2·10	2957
1·40	0·7338	6·97	8·15	8·75	9·35	59318	69278	76227	1079·2	1079·2	0·0894	2·07	3744
1·58	0·8291	7·87	9·35	9·95					1218·0	1218·0			
1·72	0·9015	8·58	9·95						1325·9	1325·9			

59. Manganese Core Volume 231 · Mass 1673 Density 7.22.

Clock Obsd	Diff'l Correct	C. in abs. u.	Magnetic Diff'n Observed	Correctd	Moments Coil from Coil	Core	T	H	κ	μ	L.
0.031	0.03	0.0157	0.46	0.1445	75741	1395	6146	26.6	23.1	1.152	15.48	357.6
0.05	0.05	0.0262	0.62	0.62	10507	1969	8538	36.9	38.5	0.958	13.04	5020
0.102	0.10	0.0524	1.10	1.079	18255	3821	14464	62.6	77.1	0.812	11.21	8642
0.205	0.2	0.1048	2.23	2.176	36876	8389	28487	123.3	154.2	0.800	11.05	17040
0.30	0.3	0.1572	3.27	3.27	55416	12405	43011	186.1	231.3	0.804	11.10	2567
0.402	0.4	0.2096	4.37	4.348	73684	16947	56737	245.5	308.3	0.796	11.00	3391
0.5035	0.5	0.2621	5.44	5.343	90885	21183	69702	301.5	385.4	0.782	10.83	4173
0.6045	0.6	0.3145	6.25	6.204	105137	25505	79632	344.5	462.5	0.745	10.36	4791
0.698	0.7	0.3669	7.23	7.25	122864	30980	92784	401.4	539.6	0.737	10.26	5536
0.797	0.8	0.4193	8.11	8.114	137946	34741	103205	446.4	616.7	0.724	10.10	6228
0.892	0.9	0.4717	8.89	8.969	151995	38808	113187	489.6	693.8	0.705	9.86	6841
0.993	1.0	0.5241	9.7	9.768	165535	43384	122151	528.7	770.9	0.686	9.62	7417
1.203	1.2	0.6289	11.33	11.3	191498	50925	140573	608.0	925.0	0.657	9.26	8566
1.42	1.4	0.7338	12.82	12.64	214206	59313	154893	669.9	1079.2	0.621	8.80	9495
1.65	1.58	0.8281	14.44	13.54	229458	69278	160180	692.8	1218	0.569	8.15	9924
1.75	1.72	0.9015	15.7	15.43	261488	74227	187261	810.1	1325.9	0.611	8.68	11508

Last Obs. Volume 2.4 Mar. 1651 Density 7.6

Magnetic Deflection Ord	C Required	C Obtd.	Magnetic Defl. Corrected	Moments Bott + core	Bott Coil	Core	I	H	k	μ	L
0.031	0.03	0.0157	0.35	0.339	57145	13195	43350	18.8	23.1	0.814	11.23	259.4
0.05	0.05	0.0242	0.58	0.58	98229	19669	78560	34.0	38.5	0.883	12.10	465.8
0.101	0.10	0.0524	1.12	1.109	187194	38271	148923	64.8	77.1	0.840	11.56	891.1
0.2.03	0.2	0.1148	2.23	2.188	370719	83829	286890	124.1	154.2	0.805	11.12	1714
0.3.0	0.3	0.1572	3.33	3.32	562263	124605	438858	189.7	231.3	0.820	11.31	2616
0.4.0	0.4	0.2096	4.46	4.45	754413	169467	584466	252.9	308.3	0.820	11.31	3486
0.5.005	0.5	0.2621	5.55	5.534	937833	211833	726000	314.1	385.4	0.815	11.24	4331
0.6.	0.6	0.3145	6.70	6.69	1133733	255505	878868	380.1	462.5	0.821	11.32	5235
0.7	0.7	0.3669	7.75	7.73	1309998	300050	1009948	436.5	539.6	0.801	11.07	5973
0.7.97	0.8	0.4193	8.69	8.70	1474887	347461	1127426	487.7	616.7	0.791	10.94	6747
0.8.96	0.9	0.4717	9.64	9.663	1637366	398808	1244948	540.5	693.8	0.779	10.79	7485
1.02	1.0	0.5241	10.61	10.382	1759461	433884	1325587	573.4	770.9	0.744	10.35	7979
1.21	1.2	0.6289	12.61	12.28	2088105	509925	1571180	679.8	925.0	0.735	10.24	9470
1.45	1.4	0.7338	14.21	13.72	2325909	593313	1731196	749.1	1079.2	0.694	9.72	10486
1.56	1.58	0.8281	15.02	15.19	2572251	692278	1879973	813.0	1218.0	0.668	9.39	11436
1.72	1.72	0.9015	16.2	16.17	2740028	740227	1998801	984.4	1325.9	0.745	29.86	13448

Cast wrought iron imperfect casting Mr. Jas. Mason 17th December 1866

Obsch Obst	Defln Required	C. abs. K.	Magnetic Observed	Defln Corrected	Moments Girl + cow	Coil	Core	I	H	K	μ	L
0.03	0.03	0.0157	0.4	0.393	6660	1395	5265	22.8	23.1	0.987	13.40	309.5
0.0501	0.05	0.0262	0.6	0.599	10151	1969	8182	35.4	38.5	0.919	12.55	483.1
0.102	0.10	0.0524	1.15	1.138	19285	3821	15464	66.9	77.1	0.8768	11.91	918.2
0.205	0.20	0.1048	1.26	2.225	37706	8389	29317	126.8	154.2	0.822	11.33	1747
0.299	0.30	0.1572	3.3	3.341	56619	12405	44214	191.3	231.3	0.827	11.39	2634
0.398	0.40	0.2096	4.47	4.523	76650	16947	59703	258.3	308.3	0.838	11.53	3564
0.505	0.50	0.2621	5.59	5.475	92783	21183	71600	309.8	385.4	0.804	11.10	4277
0.595	0.60	0.3145	6.58	6.675	113119	25505	87614	379.0	462.5	0.819	11.29	5221
0.698	0.70	0.3669	7.72	7.792	132049	30050	101969	441.1	539.6	0.809	11.17	6027
0.797	0.80	0.4193	8.76	8.792	148995	34741	114254	494.4	616.7	0.801	11.06	6820
0.899	0.90	0.4717	9.79	9.86	167096	38808	128286	552.9	693.8	0.800	11.05	7666
1.	1.0	0.5241	10.87	10.87	184211	43384	140827	609.1	770.9	0.790	10.93	8424
1.21	1.2	0.6289	12.78	12.67	214715	50925	163790	705.4	925.0	0.766	10.63	9832
1.43	1.4	0.7338	14.49	14.19	240474	59313	181161	783.5	1079.2	0.726	10.12	10918
1.585	1.58	0.8281	15.47	15.42	261318	69278	192040	830.7	1218.0	0.682	9.57	11655
1.79	1.72	0.9015	16.75	16.27	275723	74227	201496	871.5	1325.9	0.657	9.26	12279

Water iron core Volume 231 [redacted] 1815 [redacted]

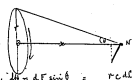
Orach. Obs.	Defl. required	C. abs. w.	Magnet. Defl. Observed	Corrected	Moments Coil + core	Coil	Core	I	H	k	μ	δ
0.0305	0.03	0.0157	0.32	0.315	5338	1395	39443	17.05	23.1	0.738	10.27	237.2
0.05	0.05	0.0242	0.55	0.555	9405	1969	7436	32.16	38.5	0.835	11.49	442.3
0.1	0.1	0.0524	1.125	1.135	19235	3821	15414	66.67	77.1	0.865	11.87	915.1
0.203	0.2	0.1048	2.31	2.286	38740	8389	30351	131.30	152.2	0.851	11.70	1804
0.3	0.3	0.1572	3.44	3.44	58297	12405	45892	198.5	231.3	0.858	11.78	2724
0.4	0.4	0.2096	4.53	4.513	76769	16947	59822	258.7	308.3	0.839	11.54	3558
0.5	0.5	0.2621	5.71	5.74	97274	21193	76091	329.1	385.4	0.854	11.73	4520
0.6	0.6	0.3145	6.82	6.85	116075	25505	90580	391.8	462.5	0.847	11.64	5383
0.699	0.7	0.3669	7.99	8.04	136268	30080	106188	459.3	539.6	0.843	11.59	6254
0.795	0.8	0.4193	9.10	9.197	155859	34741	121,118	523.9	616.7	0.849	11.67	7196
0.90	0.9	0.4717	10.32	10.37	175737	38808	136929	592.3	693.8	0.855	11.74	8143
1.0	1.0	0.5241	11.5	11.55	195734	43384	152350	659.0	770.9	0.855	11.74	9050
1.235	1.2	0.6289	14.21	13.87	235857	50925	184,126	796.4	925.0	0.861	11.82	10933
1.43	1.4	0.7338	16.35	16.07	272333	57313	213020	921.4	1079.2	0.854	11.73	12655
1.58	1.58	0.8251	18.1	18.17	307922	69279	237,644	1032.2	1218.0	0.847	11.64	14176
1.8	1.72	0.9015	20.24	19.41	328935	74227	254,708	1101.7	1325.9	0.831	11.44	15168

Norway Iron core Volume 231 Mass 1885 g, Dec. 5, 1910

Applied Defl. Red.	Applied Defl. Required	Current in abs. units	Magnetic Defln. Red.	Magnetic Defln. Corrected	Moments Coil & core	Coil	Core	I	H	k	μ	L.
0.030	0.03	0.0157	0.325	0.320	5423	1395	4028	17.42	23.1	0.754	10.47	241.9
0.051	0.05	0.0262	0.590	0.579	9812	1969	7843	33.92	38.5	0.881	12.07	464.7
0.10	0.10	0.0524	1.125	1.105	19065	3821	15244	65.93	77.1	0.855	11.75	905.8
0.200	0.20	0.1048	2.35	2.304	39045	8389	30656	132.59	154.2	0.860	11.81	1821
0.302	0.30	0.1572	3.50	3.477	58921	12405	46519	201.21	231.3	0.870	11.93	2759
0.401	0.40	0.2096	4.68	4.673	79192	16947	62245	269.23	308.3	0.873	11.97	3690
0.502	0.50	0.2621	5.85	5.831	98816	21183	77633	335.8	385.4	0.866	11.88	4578
0.598	0.60	0.3145	6.98	7.013	118847	25505	93342	403.7	462.5	0.873	11.97	5536
0.70	0.70	0.3669	8.18	8.193	138844	30080	108764	470.4	539.6	0.872	11.96	6453
0.800	0.80	0.4193	9.420	9.377	158,909	34741	124168	537.1	616.7	0.871	11.94	7363
0.900	0.90	0.4717	10.62	10.570	179,127	38808	140319	606.9	693.8	0.875	12.00	8325
0.998	1.00	0.5241	11.70	11.74	198,954	43384	155570	672.9	770.9	0.873	11.97	9228
1.220	1.20	0.6289	14	14.185	240,389	50925	189464	819.5	925.0	0.886	12.13	11222
1.405	1.40	0.7338	16.65	16.61	281,285	59313	222172	996.1	1079.2	0.923	12.60	13595
1.600	1.58	0.8281	18.85	18.64	315,886	69278	246608	1066.7	1218.	0.876	12.01	14625
1.82	1.72	0.9015	20.95	19.83	336,053	74227	261826	1132.5	1325.9	0.854	11.73	15551
1.82												

Deflection	Tangent	Long. r^2+x^2	Ammeter $\frac{(r^2+x^2)^{3/2}}{2\pi r^2}$	Indicating Current in amperes $\times 10 \times 2.14$	Deflection	Tangent	Long. $x_{inc.}$ R_{Ohms}	x	r^2+x^2	$\frac{(r^2+x^2)^{3/2}}{2\pi r^2}$	Current in amperes $\times 10 \times 2.14$
1	11	157	7.017	15.32	31	41	1717				
2	12	180	8.697	16.52	32	42	1800	337.62	314.56	297.63	
3	13	205	10.676	20.28	33	43	1885	361.81	687.4		
4	14	232	12.976	24.65	34	44	1972	387.15	735.6		
5	15	261	15.622	29.68	35	45	2061	413.65	785.9		
6	16	292	18.641	35.42	36	46	2152	441.35	838.6		
7	17	325	22.059	41.91	37	47	2245	470.26	893.5		
8	18	360	25.903	49.22	38	48	2340	500.43	950.8		
9	19	397	30.198	57.38	39	49	2437	531.86	1010.5		
10	20	436	34.971	66.44	40	50	2536	564.60	1073		
11	21	477	40.248	76.47	45	55	2061	748.71	1422		
12	22	520	46.057	87.51	50	60	3636	969.29	1842		
13	23	565	52.423	99.60	55	65	4261	1229.7	2336		
14	24	612	57.373	112.81	60	70	4936	1533.1	2913		
15	25	661	66.934	127.17	65	75	5661	1883.0	3578		
16	26	712	75.131	142.75	70	80	6436	2282.7	4337		
17	27	765	83.992	159.58	75	85	7261	2735.3	5197		
18	28	820	93.543	177.73	80	90	8136	3246.4	6164		
19	29	877	103.81	197.24	85	95	9061	3813.1	7245		
20	30	936	114.82	218.16	90	100	10036	4444.4	8445		
21	31	997	126.60	240.54	95	105	11061	5142.9	9772		
22	32	1060	139.175	264.43	100	110	12136	5910.6	11230		
23	33	1125	152.57	289.88	105	115	13261	6751.2	12827		
24	34	1192	166.82	316.96	110	120	14436	7668.1	14569		
25	35	1261	181.94	345.7	115	125	15661	8664.6	16463		
26	36	1332	197.97	376.1	120	130	16936	9743.9	18513		
27	37	1405	214.92	408.3							
28	38	1480	232.93	442.4							
29	39	1557	251.72	478.3							
30	40	1636	271.61	516.1							
			292.55	555.8							

If a current flow in the ring the action of one element of this current dl on the needle at N will be $dF = \frac{c\,dl}{r^2+z^2}$



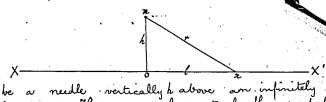
of this the horizontal component

will be $dH = dF \sin\theta = \frac{rc\,dl}{(r^2+z^2)^{3/2}}$

Summing these elementary actions we have $H = \frac{2\pi r^2 c}{(r^2+z^2)^{3/2}}$

And $c = \frac{H(r^2+z^2)^{3/2}}{2\pi r^2}$

For the long ampere meter $r = 6$ $2\pi r^2 = 226.2$



If n be a needle vertically h above an infinitely long wire XOX'. Then an element of the conductor situated at x exercises a force on n

$$dF = \frac{c\,dl}{h^2+l^2}$$

of which the horizontal component is

$$dH = \frac{c\,dl}{h^2+l^2} \times \frac{h}{\sqrt{h^2+l^2}} = \frac{ch\,dl}{(h^2+l^2)^{3/2}}$$

$$\int dH = ch\int_{-l}^{+l}\frac{dl}{(h^2+l^2)^{3/2}}$$ the integral is $\frac{l}{h^2(h^2+l^2)^{1/2}}$

whence $H = ch\left(\frac{+l}{h^2 l} - \frac{-l}{h^2 l}\right) = \frac{2c}{h}$

Wednesday 20th June.

The following observations were made with the view of determining H.

The Gauss Magnetometer was used as the H pair.

The scale was 250·85 distant from the mirror.

The time of oscillation with the magnet was determined by chronograph as follows:— 195 complete vibs: took place in 2262·82 secs. or 11·6041 secs per swing.

The amplitude was $\tan^{-1}\frac{7\cdot0}{250\cdot85}$ to $\tan^{-1}\frac{1\cdot6}{250\cdot85}$ in the line

Temp: 29° C.

When the magnet was loaded with the brass ring, the time of vib: became 25·315 secs: ·88 vibs being completed in 2227·72 seconds. The amplitude of angular motion being from $\tan^{-1}\frac{10\cdot94}{250\cdot9}$ to $\tan^{-1}\frac{1\cdot77}{250\cdot9}$ temp: 29·5° C.

Torsion $\frac{\pi}{2}$ + 2·482
$\frac{\pi}{2}$ − 2·538 } Mean 2·495 special suspension

The torsion with the unloaded magnet was
$\frac{\pi}{2}$ + 0·09
$\frac{\pi}{2}$ − 0·08 } Mean 0·085

---

*The weight of the ring is 167·279 g. and its moment of inertia is 1087·31 cm. gm.

The time of oscillation for the unloaded magnet corrected for torsion is

$$t^2 = \frac{5400+v}{5400}(11.604)^2 \quad \text{where } v = \tan^{-1}\frac{0.085}{250.89}$$

$$= \tan^{-1} 0.000 3388 = 1'.15$$

$$t^2 = 1.000213 \times 134.6528 = 134.681$$

The time of oscillation for the loaded magnet corrected for torsion is

$$t^2 = \frac{5400+v}{5400}(25.315)^2 \quad \text{where } v = \tan^{-1}\frac{2.495}{250.9} =$$

$$= \tan^{-1} 0.009 9442 \qquad \therefore v = 34.3'.$$

$$t^2 = 1.006352 \times 640.8492 = 644.9199.$$

The moment of inertia of the magnet is

$$= \frac{134.681}{644.920 - 134.681} \times 1087.31$$

$$= \frac{134.681}{510.239} \times 1087.31 = \frac{146439.98}{510.239}$$

$$= 287.002$$

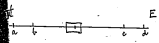
The time of oscillation $= \sqrt{134.681}$

$$\therefore MH = \frac{4\pi^2 \times 287.002}{134.681} = \frac{39.478 \times 287.002}{134.681}$$

$$= \frac{11330.3798}{134.681} = 84.1275$$

On the 30th of April see Book 2 p. 24 the product MH was 87.112.

The deflections were as follows.



Torsion $\frac{\pi}{2}$ − 0.42 −

$\frac{\pi}{2}$ + 0.41 +

Temp. 30°C.

Position	End of mount	Deflection
a	S	8.23 +
d	N	8.28 +
c	N	20.21 +
b	S	20.12 +
b	N	20.20 −
c	S	19.89 −
d	S	8.19 −
a	N	8.29 −
a	N	8.295 −
d	S	8.19 −
c	S	19.89 −
b	N	20.21 −
b	S	20.09 +
c	N	20.22 +
d	N	8.295 +
d	S	8.23 +

	a	d	b	c
−	8.23	+8.28	+20.12	+20.21
+	8.29	−8.19	−20.20	−19.89
+	8.295	−8.19	−20.21	−19.89
−	8.23	+8.295	+20.09	+20.22
	8.261	8.239	20.13	20.053
	8.250		20.091	

Scale dist. 213.5

The corrected deflections are

$$\frac{5400+v}{5400} \times 8.250 = 1.001222 \times 8.250 = 8.2601$$

$$\frac{5400+v}{5400} \times 20.091 = 1.001222 \times 20.091 = 20.1156$$

where $v = \tan^{-1}\frac{0.415}{213.5} = \tan^{-1} 0.001943 = 6.6'$

$$\tan^{-1}\frac{8.260}{213.5} = 0.038688 = 2^\circ.12'.55''$$
sin of which = 0.038663

$$\tan^{-1}\frac{20.1156}{213.5} = 0.094218 = 5^\circ.23'.57''$$
sin of which = 0.094094

$$p = \frac{\left(\frac{50}{2}\right)^3 \times 0.038663 - \left(\frac{37.5}{2}\right)^3 \times 0.094094}{25 \times 0.038663 - 18.75 \times 0.094094}$$

$$= \frac{2416.5 - 2481.0}{0.96658 - 1.7623} = \frac{-64.5}{-0.7957}$$

$$= 81.059.$$

$$\frac{M}{H} = \frac{1}{2}\left(50\right)^3 \times 0.038663 \left(1 - \frac{81.059}{(50)^2}\right)$$

$$= 125000 \times 0.193315 \times 0.9675764$$

$$= 2338.088$$

$$\therefore H^2 = MH \div \frac{M}{H} = \frac{84.12765}{2338.088} = 0.03598132$$

$$\therefore H = \underline{0.1897}$$

$$M^2 = MH \times \frac{M}{H} = 196697.66$$

$$M = 443.14. \quad @ \ 29.5^\circ \text{ c.}$$

On the 30th April, H was determined to be 0.1891 and M 0.4460.6 @ 22°.c.

Primary Batteries — Robert = Brevoort

Date & Time	Hours work	No.	P.D.	EMF	C.	I.R.	
9.6.88 8.00.	95	1	1·165	1·408	2·320	0·102	
		2	1·042	1·197	2·084	0·074	
		3	0·944	1·944	1·948	0·077	
9.6.88 18.00.	105	1	0·888	1·078	1·776	0·106	
		2	0·718	0·824	1·436	0·073	
		3	0·636	0·748	1·272	0·088	
20.6.88 8·00	119	1	0·588	0·618	1·016	0·108	
		2	0·511	0·575	1·022	0·083	
		3	0·496	0·580	0·992	0·094	
13·00	124	1	0·491	0·571	0·982	0·101	
		2	0·504	0·577	1·008	0·072	
		3	0·470	0·550	0·940	0·085	
18·00	129	1	0·476	0·576	0·952	0·105	
		2	0·498	0·548	0·996	0·070	
		3	0·448	0·516	0·896	0·075	
21.6.88 8·00	143	1	0·408	0·493	0·816	0·104	
		2	0·424	0·478	0·848	0·063	
		3	0·410	0·452	0·820	0·081	
18·00	153	1	0·398	0·474	0·796	0·075	
		2	0·424	0·460	0·848	0·052	
		3	0·400	0·480	0·800	0·100.	
22.6.88 8·00	167	1	0·384	0·462	0·768	0·101	
		2	0·400	0·461	0·800	0·076	
		3	0·392	0·450	0·784	0·073	
12·0	171	1	0·394	0·470			
		2	0·414	0·442			
		3	0·395	0·442.			

Cells taken down much H₂O being evolved & liquid lost

Friday. 22nd June.

Received at laboratory 10 antimagnetic Watches as follows —

Watch No.	Grade	Name.	Number	Price
1	1st	Paillard	57. 872	$ 67.50
2	2nd	"	56. 608	$. 22.50
3	3rd		350 4348	$ 7.50
4	1st	Waltham	3,457,605	$ 21.00
5	2nd		3,534,804	$ 18.00
6	3rd		3,511,918	$. 5.00
7	1st	Elgin + sup shill	3,073,718	$. 8.50
8	2nd		3,040,188	$ 6.25
9	1	Hampden	1,73,861	$ 8.50
10	1	Patek Philippe	76,772	—

Weighed meter plates and set them in solution of pure neutral $ZnSO_4$ 1.054 cleaned the zinc. but did not amalgamate them

Number	Weight	Combined weight	Number	Weight	Combined weight
1	21.2983	43.7064	11	20.2825	40.4863
2	22.4149		12	20.2032	
3	21.1228	43.1279	13	21.5329	42.7356
4	22.0048		14	21.2023	
5	21.6857	42.9366	15	21.3436	42.5194
6	21.2486		16	21.1554	
7	21.6872	43.1524	17	20.7749	41.2108
8	21.4277		18	20.4355	
9	22.0648	42.5334	19	21.9550	42.2935
10	20.4673		20	20.3381	

36 × 2·2 = 265

450 | 1370
1785
3730
2470

	Beyond Fixed Deflect.	Reversed Fixed Deflect.	Current in abs. units	Moment Magnetic Deflect.	Corrected Magnetic Deflect.	Moment of Coil rev.	Moment of Cont.	Moment of rev.	I"
Small coil	0·1	0·1	0·0524	0·06	0·06		357	1363	
	0·2	0·2	0·1048	0·11	0·11		652	7226	
	0·4	0·4	0·2096	0·205	0·205		1186	11452	
	0·6	0·7	0·3669	0·39	0·38		2213	25141	
	0·997	1·0	0·5241	0·51	0·525		3110	36230	
Large coil	0·1	0·1	0·0524	0·065	0·065		285		
	0·2	0·2	0·1048	0·10	0·10		592		
	0·4	0·4	0·2096	0·230	0·28		1660		
	0·7	0·7	0·3669	0·48	0·47		2790		
	1·0	1·0	0·5241	0·70	0·67		3970		
	0	0	0	0·03	0·03				
Small coil open	0·1	0·1	0·0524	0·41	0·41	2432	357	2075	
	0·2	0·2	0·1048	0·865	0·86	5100	652	4448	
	0·4	0·4	0·2096	1·75	1·75	10378	1186	9192	
	0·7	0·7	0·3669	3·08	3·11	18444	2213	16231	
	0·997	1·0	0·5241	4·42	4·48	26570	3110	23460	101·5
	0	0	0	0·03					
Large coil open	0·101	0·10	0·0524	0·401	0·406	2408	285	2023	
	0·200	0·2	0·1048	0·695	0·795	4714	592	4122	
	0·4	0·4	0·2096	1·69	1·71	10142	1660	8482	
	0·7	0·7	0·3669	3·01	3·04	18029	2790	15242	
	0·999	1·0	0·5241	4·41	4·45	26390	3970	22420	57·9
	0	0	0	0·05					

Friday 22nd June

Continued experiments on coil-winding as follows

40 metres of cotton-covered wire were wound on each of two brass core-cover. The mean diam: of the smaller coil was 4·69 cms that of the larger 6·47. The lengths of the coils were (16 cms) equal. There were 197 turns on the larger and 270 on the smaller. The dist: from coil centre to needle 238·5

" " " scale — — 2216

H	Ratio of H	Total Pow £					
		192					
		384					
		768					
		1544					
		4320					
		267					
		533					
		1066					
		1865					
		2665					
11·11		1910					
22·22		4006					
44·44		8151					
77·77		14425					
111·1	1·371	20870					
8·11	0·7295	1891					
16·21		3703					
32·42		7965					
56·74		14159					
81·06		20726					

Saturday 23rd June

Ran 2 armatures in the no 1. Machine
No 1 was of the ordinary type
- 2 had an core of oxydized iron wire instead of iron

No 2 Ran at an average speed of 3920 revs: from 10.22 to 11.22 with a charging current through its fields of 1.5 ampere. It had 44 coil of wire and its res: was 2.7Ω so that each coil had a res: of $\frac{5.4}{22} = .2245\Omega$

~~after~~ The voltage by 2 AP wires in series was 222 at that speed. As soon as it stopped it was immersed in a bath of about 43,200 c.c. of water, and allowing for the rise from the heat of the room, it caused a rise of temp: in 35 mins of 6°F (74°-68°) or about $\frac{259200}{9}$ calories

No. 1. Ran at an average speed of 3820 revs (some slip on belt) generating at the same velocity as no 2 (3920) 274 volts from 11.32 to 12.32, the changing current and other conditions being the same: At 12.34 this armature was immersed in another bath of about 43200 c.c. H2O and raised its temp: allowing for heat of room 11°F (74° − 85°) = $\frac{1752000}{9}$ H.U.

So that while the voltage of no 2 was 19% short of that given by no 1, the 25 Heat units of heat was 14400 units against 26400 units in no 1 or 45.5% short and the mean still has heat generated by

copy [illegible]

Clock + Watch Rates

Date	Clock Error	Difference	Days.	Rate.	Pos of Winding	Days of repairs			Watch error	Diffce	Days.	Rate
25. 6. 88	0				9 am.				20 −			
26. 6. 88	6.75+	6.75+	1	6.75+					42 −	8 +	1	8+
27. 6. 88	8.6+	0.15+	3	0.05+	9.0							
28. 7. 88	21.4+	13.3+	3	4.4+	Noon							
29. 7. 88	23.3+	6. +	4	1.5+	Noon							
30. 7. 88	26.2+	1.7 −	1	1.7 −								
31. 7. 88	20. +	6.2 −	3	2.07 −								
11. 7. 88	17. +	3. −	1	3.0 −								
12. 7. 88	34.2+	17.2+	1	17.2+								
14. 7. 88	36.5+	5.3+	2	2.65+								
18. 7. 88	42.0+	5.5+	4	1.4+								
19. 7. 88	47.75+	1.75+	1	1.75+								
23. 7. 88	49.0+	5.25+	4	1.68+								
24. 7. 88	49.4+	0.5+	1	0.5+								
25. 7. 88	51.5+	2.1+	1	1.5+								
27. 7. 88	19.5+	−32										
29. 7. 88	56.4+	2.0+	2	1.0+								
31. 7. 88	60.5+	4.1+	2	2.05+								
2. 8. 88	61.5+	7.5	3	1.5+								
3. 8. 88	63.3+	2.0	1	2.0+								
4. 8. 88	66.25	2.75	1	2.75+								
9. 8. 88	63.5	−2.75										
11. 8. 88	74.	10.5	9	1.2+								
14. 8. 88	80	6	3	2.0+								
22. 8. 88	98.2	18.2	8	2.3+								
23. 8. 88	99.2	1	1	1								
25. 8. 88	96.2	−3	3	−1								

Particulars of Robert Brewster Cells

Cell no 1. has done most work, + consumed most

Cell	Weight of Zinc before	Weight of Zinc after	Loss. grammes	Joules Externally	Joules Internally	Ratio	Total Joules	Joules per gramme
1	3628	2328	1300	5026700	177370	28.34	5204070	3975
2	3628	3084	544	3574800	293630	12.17	3868430	6570
3	3628	3112	516	3543800	292480	12.12	3835980	7434

Cell	Weight zinc before	Weight of Zinc after	Loss	Joules Externally	Joules Internally	Ratio	Total Joules	Joules per gramme
Cells 1 2 3	3628	2840	788	4051700	254490	16 6.28%	4,306,190	5460

Tried following experiment with a phonograph motor ring of single winding. One bedplate received four pair of magnet cores of cast iron. Their diameters were 1.5" 2" 2.5" + 3" respectively). These couples were set in succession at the same point 90° apart and the ring was spun by a motor. Currents of known strengths were supplied to the coils of the two cores to follow.

Coils used	Speed observed	Speed required	Observed P.D. Deflect	Corrected P.D. Deflect	Speed observed	Speed required	Observed P.D. Deflect	Corrected P.D. Deflect
1.5"	1161	1350	110	12.8	1638	1350	214	176.3
2."	1281	1350	128	128.8	1422	1350	243	230.7
2.5"	1286	1350	120	135.5	1368	1350	225	222
3."	1602	1350	115	97	1188	1350	165	187.5

Connected the four sets of cores in succession at a definite distance, and connected a wire to pass between the poles with the ballistic galvr.

Cores	Current	Current	Throw Rel. Outer.	Mean	Ratio	Current	Throw	Mean	Ratio
1½	18°30'	2·5	23		1½	6	32·25	34·38	1
	18°45'		24	24			34·5		
	19°30'		23·25						
2	18°25'	2·5	29·5			6	53	53·3	1·55
	18°25'		30	30			53·5		
	18°30'		31						
2½	18°25'	2·5	27			6	61·5	62·5	1·81
	18°25'		27	26·67			63·5		
	18°25'		26				63·5		
3	18°25'	2·5	29·5			6	65	65	1·90
	18°25'		29·5	29·63			65		
			29						

Monday 25th June

Meters set to work at 9.30 through 70.

Thursday 28th June.

6 Watch cases arrived from the non-mag H.C. and also a winder.
Took the errors of the watches after winding them up and setting them approximately to time by the clock. 13.28 o'clock T. 70°F

1.	2	3	4	5	6	7	8	9	10	11
-17	+34	+77	-19	-12½	-46½	+94	+139	+27	-65	+56½

all watches left under glass stands in case dial up

Friday 29th June.

8.40 o'clock T. 62°F

1	2	3	4	5	6	7	8	9	10	11
-20	+28	+74	+34½	+12½	+26	-39½	-30½	+46	+86½	+51½

Found nos 4 5 6 7 +8 stopped. Reset them.

Refrigerator + hot-box arrived.

Compared Voltmeters as follows:—
Mains connected thro: 10000 ω, 100 ω of ratio coil being taken to potentiometer circuit.

Ayrton Perry 130 Voltmeter Error 0.2 — at 120
" " " 150 " " 2.2 — at 120
Temp. 19°. C.

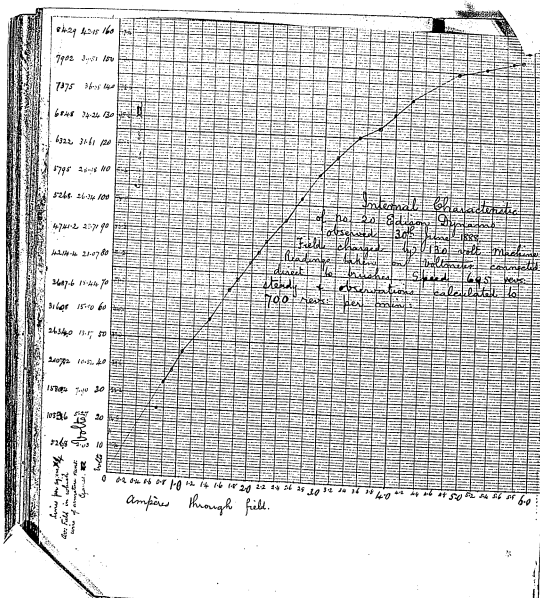
Connected chemical room with Dynamo room current through leads in main circuit giving 150 ampere (circa).

Watch errors Saturday 30th June. 8.40 o'clock dial up T. 64°

1	2	3	4	5	6	7	8	9	10	11
-22¾	+21	+19	+9	-24¾	+13½	-17½	-32	+69½	+1400	+44½
10½	-2¾	-7	-5					+25½	-48½	-7½

Took the errors of the ammeters as follow. (52)

Time of Obs.	Mach. Deflec.	Current from Mach.	15 Am. Reading	0 Amp. Reading	5 Am. Reading	Error	1 Amp Reading	Error
0	0	0	0.14	0.14 +	−0.01	−0.01	0.022	+0.022
5°.20'	0.025	0.131	0.5	0.374	0	−0.13	0.115	−0.016
5°.30'	0.039	0.204	0.5	0.30 +	0.	−0.20	0.175	−0.03
5°.5'	0.060	0.314	0.5	0.19 +	0.05	−0.24	0.298	−0.02
5°.10'	0.079	0.414	0.5	0.08 +	0.1	−0.31	0.394	−0.02
5°.20'	0.100	0.524	0.5	0.02 −	0.25	−0.27	0.487	−0.04
5°.35'	0.120	0.628	0.5	0.03 −	0.5	−0.13	0.578	−0.06
5°.35'	0.143	0.749	0.7	0.05 −	0.62	−0.13	0.715	−0.03
6°.5'	0.158	0.827	0.8	0.03 −	0.68	−0.15	0.785	−0.04
6°.50'	0.170	0.890	0.9	0.01 +	0.715	−0.17	0.840	−0.05
7°.45'	0.196	1.026	1.0	0.03 −	0.9	−0.13	0.975	−0.05
8°.17'	0.398	2.084	2.1	0.02 −	1.93	−0.15		
22°.2'	0.585	3.063	3.03	0.03 −	2.92	−0.14		
28°.40'	0.766	4.010	4.00	0.01 −	3.77	−0.23		
34°.20'	0.953	4.990	5.10	0.11 +	4.57	−0.42		
39°.20'	1.139	5.963	6.25	0.29 +				
43°.35'	1.313	6.874	7.2	0.33 +				
47°.30	1.490	7.801	8.35	0.55 +				
50°.45	1.680	8.796	9.2	0.40 +				
53°.45	1.870	9.791	10.1	0.30 +				
56°.40'	2.070	10.84	11.1	0.26 +				
59°.15'	2.265	11.86	12.2	0.34 +				
64°.40'	2.87	15.03	14.0	1.0 −				
65°.10'	2.93	15.34	15.3	0.04 −				



Saturday 30th June.

Internal of the No. 20 Dynamo after it has the speed of 700 revs. per min.

Current in Field	Volts.					
	Non Observed	Accepted Current in Field	Volts by curve 82	Volts by 120 v. curve	Accepted Voltage	Voltage calc. this to 700 rev
	-	0·7	29	30	29·5	29·7
	-	0·79	33	35	34	34·2
	-	0·90	38	39	38·5	38·7
	-	1·04	46·5	46·5	46·5	46·8
	1·4 - 1·43	1·41	57	57·8	57·4	57·8
	1·7 - 1·72	1·68	67·4	69·1	68·3	68·8
	1·8 - 1·82	1·80	72	72·2	72·1	72·5
	2·0 - 2·02	1·98	78·8	77·8	78·3	78·9
	2·1 - 2·12	2·09	81·6	82·1	81·9	82·5
	2·2 - 2·22	2·19	85·3	86·2	85·8	86·4
	2·45 - 2·47	2·444	92·6	94·6	93·6	94·2
	2·7 - 2·72	2·69	100·5	102·4	101·5	102·2
	2·95 - 2·97	2·94	110·5	110·0	110·3	111·0
	3·2 - 3·22	3·19	116·5	116·0	116·6	117·4
	3·5 - 3·52	3·49	123·0	123·2	124·2	125·0
	3·8 - 3·81	3·79	127·2	128·2	127·7	128·5
	3·95 - 3·97	3·98	132·4	132·6	132·9	133·8
	4·2 - 4·22	4·22	5	136·0	138·2	139·1
	4·50	4·89		146·0	147·2	149·2
	5·5	5·31		155·5	158·7	151·7
	6·0	5·71		158·0	158·2	154·2
	6·1	5·81		161·5	153·7	154·7

Saturday 30th June.

Took characteristic of the No. 20 Dynamo after Worked out to the speed of 700 revs. per min.

Speed	Current in Field					Volts.			
Speed.	H+B Ammeter	H+B Ammeter	H+B Ammeter	Accepted Current in Field	Volts by Accel 120	Volts by 120 revs Accepted	Accepted Voltage	Voltage calculated to 700 rev
6.45	0.65	0.70	–	–	0.7	29	30.	29.8
11.30	0.75	0.79	–	–	0.79	33	35	34.2
	0.85	0.90	–	–	0.90	38	39	38.7
	1.0	1.05	0.9-1.05	–	1.04	44.5	46.5	45.8
			1.25	1.30	1.25-1.30	1.41	57	57.8	57.4	57.8
			1.5	1.61	1.7. 1.72	1.68	67.4	69.1	68.3.	68.8
6.45			1.64	1.75	1.8 1.82	1.80.	72	72.2	72.1	72.5
7.45			1.8	1.95	2.0 2.02	1.98	78.8	77.8	78.3	78.9
			1.9	2.05	2.1 2.12	2.09	81.6	82.1	81.9.	82.5
			2.0	2.15	2.2 2.22	2.19	85.3	86.2	85.8	86.4
			2.25	2.40	2.45 2.47	2.44	92.6	94.6.	93.6	94.2
			2.5	2.65	2.7 2.72	2.69	100.5	102.4	101.5	102.2
			2.75	2.90	2.95 2.97	2.94	110.5	110.0	110.3	111.0
			3.0	3.15	3.2 3.22	3.19	118	116 117.0	116	116.6	117.4
			3.25	3.45	3.5 . 3.52	3.49	123.0	123.2	123	123.0	124.2	125.0
			3.5	3.75	3.8 3.81	3.79	127.2	127.2	128	128.2	127.7	128.5
			3.75	3.90	3.95 3.97	3.98	132.4	132.6	131	133.3	132.9	133.8
6.45			4.0	4.22	4.2 4.22	4.22			136.0	138.2	138.2	139.1
12.10.			4.4		5.0 4.89	4.89			146.0	148.2	148.2	149.2
			5.5		5.5 5.31	5.31			158.5	158.2	158.2	157.7
			6.0		6.0 5.71	5.71			168.0	163.2	158.2	154.2
			6.1		6.1 5.81	5.81			167.5	153.7	153.7	154.7

Investigation of the Magnetism of No. 20 Machine from the preceding Curve.

The length of the no 20 drum is 24.5" = 62.2cm. There are 50 blocks in the contr. each holding 3 wires making 1 turn amounting to 1172 feet in all. This wire is #5 BWG and has a res: of 0.000213 per foot. One sixth of 1172 is 195.3 = the length of each effective wire, and being in multiple one sixth of this is 32.55 which is the equivalent length of the armature this × 2.13 × 10^{4} = 6.93 × 10^{-3} = 0.006 ohm the actual res: being stated at 0.0072. The effective length for voltage is thus 50 half turns of the drum on each side. There will thus be 50 × 62.3 or 3110 cms of active wire. The mean diam. of the drum is 13.1" at the wire a circumference of 33.27 × π = 104.5 cms. A velocity of 700 revs per min = 11.667 turns per sec: = a circumferential velocity of 11.667 × 104.5 = 1220 and the differential of the area described by the wire is 1220 × 3110 = 3,792,000 sq. cms. The average field to produce one volt is thus $\frac{1.0 \times 10^{8}}{3.792 \times 10^{6}}$ = 26.37 Lines or 0.2634 Gauss.

The diameter of the hollow polar cylinder is 14" = 35.56 cms. a circumference of 111.7 cms = 55.85 cms for each pole but from this 5½" or 14 cms have to be taken for polar separation leaving 41.9 cms as the length of the polar surface. The breadth is 24.75" = 62.85 cms so that the polar surface is 62.85 × 41.9 = 2633 sq. cms

and the average number of lines passing through it is $\frac{3251.5}{2633} \times 26.35 = 3250$ per volt per sq. cm.

The average number of lines of force passing through the armature per sq. cm. per volt being $26.34 = 52.27 \times 62.2 \times 26.34 = 85{,}650$ per volt. the armature half surface being 3251.5 sq. cms. The diameter of the magnet core is $15.125'' = 38.42$ cms. and the area is thus 1158 sq. cms. The total no of lines of force being 85,650 per volt, the induction per volt in the core is $\frac{85{,}650}{1158}$ $= 73.99$ say 74 lines per sq. cm.

The wire on the core is No. 11 B.&S. 0.091 diam. having a res: of 11ω. This wire has a resistance of 0.001247 ω per foot so that $11\omega = 8.82 \times 11 = 97.02$ feet $= 29.57$ cms. The length of core being 23" = 60 cms and the number of turns to the layer about 220. The mean turn = about 40 cms so that the no: of layers $= \frac{29.57 \times 10^5}{\pi \times 2.20 \times 4.07 \times 10^5 \pi} = \frac{33}{\pi}$ and the total number of turns $33 \times 220 = 726 \div \pi = 2310$

According therefore to Kapp's Formula the induced

$$= \frac{2360 \times 2310\ A}{\frac{1440}{2633} \times 1.9 + \frac{18}{2500} + \frac{220}{1160}} = \frac{5{,}450{,}000\ A}{1.039 + 0.0073 + 0.19}$$

$$\doteq \frac{5.45\ A \times 10^6}{1.237} = 4{,}420{,}000\ A.$$

1 Ampere actually produced 44 volts

$= 44 \times 85{,}660 = 3{,}770{,}000$

Sunday 1st July

The watch data at 10 o'clock were as follows
Temp: 70°. No 7 under repair was 4s but stopped at 7½
Dial up. " 8 " " 5·10
Reversed next these and wound all others.

No 1	2	3	4	5	6	7	8	9	10	11
-24½	+12·5	+53	-51	-68½	+56½		+47	+92	-39·5	+30·5
-1½	-8½	-16		-41	+43			+22½	-19½	-6

N.	Date	1 Error	Ratio	2 Error	Ratio	3 Error	Ratio	4 Error	Ratio	5 Error
1	8.25/28.8	-17		+34		+77		-19		-12.5
2	8.24/29.6	-20	-4	+28	-7	+74	-4	+34.5	[illegible]	+12.5
3	8.24/30.6	-22.5	-2.5	+21	-7	+69	-5	9	[illegible]	-24.5
4	8.18/1.7	-20.5	-1.5	+12.5	-8.5	+59	-10	-57	[illegible]	-65.5
5	8.20/2.7	-26	-1.5	+2.5	-8.5	+39	-15	-117.5	+33.5	-99
6	8.20/3.7	-28	-2	-3	-6.5	+23	-15	+93	+27.5	-131
7	8.20/4.7	-28.5	-.5	-7.5	-5.5	+9	-14	+42	+32.5	-171.5
8	8.20/5.7	-29	-.5	-11.5	-4	-26	-35	+149.5	+27.5	-203.5
9	8.20/6.7	-27.5	+1.5	-19	-7.5	-42.5	-16.5	+85	+35.5	-238.5
10	8.20/7.7	-33.5	-6	-24	-5	-57.5	-15	+120.5	+29.5	-276
11	8.20/8.7	-37	-3.5	-32.5	-8.5	-96	-38.5	+237.5	+25.5	-305
12	8.20/9.7	-32	+5	-44	-11.5	-98.5	-2.5	+249.5	+12	-340
13	9.8/10.7	-33	-1	-56	-12	-145.5	-47	+344	+34.5	-381
14	9.8/11.7	-30	+3	-65.5	-9.5	-164	-18.5	+463	+19	-407.5
15	9.25/11.7	-33.5	-3.5	-66.5	-1.5	-114.5	+49.5	+444	-19	-407.5
16	9.25/12.7	-35.5	-2	-67.5	-1	-98.5	+16	+477.5	+12.5	-427.5
17	9.25/13.7	-47	-11.5	-69	-1.5	-76	+22.5	+573.5	+25.5	-455.5
18	10/14.7	-40	+7	-82	-13	-113.5	-37.5	+555.5	+32.5	-500
19	8/21.7	-30.5	+9.5	-91	-12	-167	-53.5	+582	+26.5	-577
20	9/22.7	-21	+9.5	-103	-9	-222	-55	+610.5	+28.5	-604.5
21	8.15/23.7	-12	+9	-114.5	-11.5	-238.5	-16.5	+638	+27.5	-658.5
22	8.16/24.7	-2	+10	-128.5	-13.5	-280.5	-42.5	+658.5	+15.5	-689
23	8.20/25.7	+10.5	+12.5	-138.5	-10	-339	-58.5	+694	+30.5	-737.5
24	8.25/26.7	+19	+8.5	-146.5	-8	-342.5	-3.5	+696.5	+2.5	-766.5
25	9/05/27.7	+27	+8	-153.5	-7	-348.5	-6	+716.5	+20.5	-801.5
26	8.25/28.7	+35	+8	-160	-6.5	-353.5	-7.5	+742.5	+26	-836
27	8.20/29.7	+35.5	+0.5	-159.5	+.5	-328.5	+25	+755	+12.5	-874.5
28	8.20/30.7	+38	+2.5	-157	+2.5	-305	+23.5	+764.5	+9.5	-913
29	8.20/31.7	+40.5	+2.5	-159	-1	-291.5	+13.5	+21	+20	-949.5
30	8.20/32.7	+41.5	+.5	-161	-2	-278	+13.5	+776.5	+12.5	-985
31	8.20/33.7	+43	+1.5	-161	0	-250	+28	+793	+16.5	-1021.5
32	10/03/34.7	+44.5	+1	-162	-1	-227.5	+22.5	+60	+15.5	-1058
33	8.20/35.7	+46	+2	-164	-2	-194.5	+33.5	+825.5	+25.5	-1103.5
34	8.20/36.7	+57	+11	-177	-13	-214	-19.5	+110	+26.5	-1142.5
35	8.20/37.7	+60	+3	-180.5	-3.5	-187.5	+26.5	+119	+9	-1179
36	8.20/38.7	+75	+15	-193	-12.5	-158	+29.5			-1222.5
37	8.15/39.7	+80	+5	-202	-9	-150	+8			-1244.5
38	8.15/40.7	+83.5	+3.5	-210	-8	-98	+52	-23		-1300
39	8.20/41.7	+88.5	+5	-215	-5	-87	+11	+195		-1325
40	8.15/42.7	+94	+5.5	-219	-4	-115	-26	+240		-1358

N.	6 Error	Ratio	7 Error	Ratio	8 Error	Ratio	9 Error	Ratio	10 Error	Ratio	11 Error	Ratio	N.
1	-46.5		+9.5		+139		+27		-65		+56.5		1
2	+4.5	51.5	-36.5	45.5	-30	169	+46	181	+85.5		+57.5	-6	2
3	+12.5	41.5	-45.5	9	-32.5	-1.5	+69.5	+23.5	-85.5	-14.5	+54.5	-7.5	3
4	+57.5	+45	-45.5	-.5	+147	174.5	+92	22.5	-57.5	-14.5	+38.5	-6	4
5	-22	34.5	-45.5	0	+107.5	54.5	+116	+24	-76.5	-19.5	+33.5	-5.5	5
6	+2	+24	+34	+17	-8	+4	+137.5	+22.5	-94	-17.5	+29	-4.5	6
7	+30.5	+10.5	+65.5	+31.5	-14.5	+6.5	+164.5	+27.5	-113.5	+19.5	+27	-2	7
8	-71.5	-32.5	+124.5	+59.5	+117	131.5	+169	+5	-131.5	-18	+18	-9	8
9	-80.5	-9.5	+154	+31.5	+109	+2	+194.5	+25.5	-149.5	-18.5	+12.5	-5.5	9
10	-101	-20.5	+209	+55	+100	-9	+217	+22.5	-169.5	-20.5	-11.5	-23	10
11	-146.5	-45.5	+246.5	+38	+82.5	-17.5	+219	+2	-186.5	-17	-22.5	-11	11
12	-172.5	-26	+267	+21	+81.5	+1.5	+237	+18	-202.5	-16	-24	-3.5	12
13	-206	-33.5	+310	+43	+80	-1.5	+252	+15	-220.5	-18	-52	-28	13
14	-238.5	-32.5	+344.5	+34	+74	-6	+251	+1	-237.5	-17	-65	-13	14
15	-261	-22.5	+385.5	+41.5	+66.5	-7.5	[illegible]	[illegible]	-256.5	-19	-72	-7	15
16	-279.5	-18.5	+411.5	+26	+55.5	-11	-1.5	+26	-273.5	-17	-72	-10	16
17	-304.5	-25	+438.5	+27	+39.5	-15.5	+21.5	+20	-292.5	-19	-100.5	-28.5	17
18	-347	-42.5	+461.5	+23	+44.5	+5.5	-20.5	-1.5	-309.5	-17	-109.5	-9	18
19	-371	-24	+485.5	+24	+44.5	+.5	+16.5	+7	-323.5	-14	-115	-5.5	19
20	-368	-17	+515.5	+27.5	+59.5	+15	+6	+15.5	-343.5	-20	-121.5	-6.5	20
21	-387.5	-19.5	+534.5	+20	+47	-12.5	+7.5	+1.5	-359.5	-16	-122.5	-1	21
22	-407	-19.5	+573.5	+39	+45	-2	+82.5	+75	-376.5	-17	-134	-8.5	22
23	-431.5	-24.5	+595	+21.5	+49	+4	+90.5	+8	-393.5	-17	-126	+10	23
24	-471.5	-40	+619.5	+24.5	+49	+0	[illegible]	[illegible]	-410.5	-17	-142.5	-16.5	24
25	-506.5	-35	+644	+24.5	+50.5	+1.5	-16	[illegible]	-426.5	-16	-145.5	-3	25
26	-545	-38.5	+668.5	+24.5	+46.5	-4	+2	+18	-444.5	-18	-152	-6.5	26
27	-587	-42	+694.5	+26	+40.5	-6	+25.5	+23.5	-464.5	-20			27
28	-629.5	-42.5	+720.5	+26	+30.5	-10	+50.5	+25	-479.5	-15			28
29	-673	-43.5	+745.5	+25	+24.5	-6	-16	[illegible]	-494.5	-15			29
30	-717.5	-44.5	+770.5	+25	+21	-3.5	+09	[illegible]	-509.5	-15			30
31	-762.5	-45	+795.5	+25	+17.5	-3.5		[illegible]	-524.5	-15			31
32	-807.5	-45	+821	+25.5	+17.5	0		[illegible]	-539.5	-15			32
33	-852.5	-45	+846.5	+25.5	+23	+5.5	-12.5		-554.5	-15			33
34	-897.5	-45	+872.5	+27	-10.5	-8.5	+10.5		-569.5	-15			34
35	-942.5	-45	+898	+25.5	-10	+.5	+16.5		-584.5	-15			35
36	-987.5	-45	+923.5	+25.5	-11	-1	+16		-599.5	-15			36
37	-1032.5	-45	+949.5	+26	-9	+2	+28.5		-614.5	-15			37
38	-1077.5	-45	+975	+25.5	-7.5	+1.5			-629.5	-15			38
39	-1122.5	-45	+1000.5	+25.5	-7	+.5			-644.5	-15			39
40	-1167.5	-45	+1026	+25.5	-6.5	+.5			-659.5	-15			40

* Probably due to [illegible] minutes [illegible] [illegible]

* Perhaps [illegible] down

Res: of Magnet 5.020

Throws from 1 standard cell 19.5°C. through 0.5Ω

136
133.75
136.9
135.3
Mean 134.99 EMF 1.4333

Temp. of room 68.9°F. = 20.5°C.

After observations

Throws from 1 standard cell 21.5°C.

135.0
135.0
135.8
135.9
Mean 135.43 EMF 1.4308

$$\mathcal{L} = \frac{d \times 0.71597 65 \times 5235 \times 10^{8}}{135.24 \times 46.57}$$

Time	Volts	Ohms.	Bring after 1 min.	Ambient temp.	Throw	Corrected	Adjusted Mean	$\mathcal{L}$
3.20	116.9	—	Initial 0.1	190.5	2.0	2.0		
.24	117		- - -		2.6 ?	2.67	1.92	114.3
.36	117		- - -		1.5	1.5		
.44	117.2		- 0.21	381	3.9 ?	3.71?		
.51	117.1		- 0.205		3. ?	2.93?	3.61	214.8
.55	117.1		- 0.21		4.21	3.902		
.59	117.2		- 0.14	762	9.25	9.25		
4.08	116.5		- 0.14		9.5 ?	9.5?	9.2	5275
.11	117.2		- 0.14		9.0	9.0		
.21	116.9	136	0.136609	1905	22.	22.1		
.29	117.1		0.136609		23	23.1	22.55	12444
.33	116.7		0.136609		22.4 ?	22.5?		
15.00	116.	76.65	0.2287 97	2857	33.8 ?	33.8 ?		
.06	115		0.2287 97		33.1	33.4	33.8	2011
.16	116		0.2287 97		34.	34.2		
.21	116.2		0.2287 97					
.26	116.3	43.88	0.3461 09	4762	54.6	54.7		
.31	116.5		0.34270		54	53.4	54.7	3255
.35	116.0		0.35783		54.9	55.5		
.42	116.7	37.43	0.40911	5733	62.7	62.85		
.46	117.0		0.40911		62.8	62.95	62.88	3741
.50	117.1		0.40911		62.9	62.95		
.55	116.9	26.44	0.52672	7620	73.9 ?	73.3 ?		
16.00	115.6		0.52672		79	78.3 ?	78.29	4471
.03	112.3		0.53332		80.3 ?	81.71 ?		
.07	116.1		0.58672		78.1	78.1		
.13	116.2	20.44	0.68321	9225	91	91.05		
.16	116.4		0.68321		90	90.05	90.46	5383
.19	115.5		0.68321		90 ?	90.05 ?		
.25	117.7	—	0.82490	11488	98.5 ?	99.3 ?		
.31	116.9		0.81703		99.1	98.5	98.43	5858
.34	116.2		0.81703		98 ?	98.4 ?		
.38	112	14.15	0.93252	13285	103.2 ?	105.7 ?		
.41	115.3		0.93252		102.9	103.2	103.66	6169
.58	116.2		0.96098		102.5	103.1		
17.01	116.1	11.85	2.7.35	15240	105.4	105.3		
.05	115.9		2.7.35		105.2	105.7	105.4	6451
.10	115.8		2.7.35		105.	105.2		
.16	115.2	9.607	50°.45'	17145	111.9	112.5		
.24	117.1		50°.00'		111.3	110.9	111.62	6643
.30	115.1		50°.45'		110.7 ?	111.5 ?		
.38	115.0		53°.50'	19050	114.4	114.3		
.41	115.5		53°.45'		113.6	113.9	114.03	6786
.44	115.3		53°.50'		114.0	113.9		

Tuesday 3rd July.

Calculation of the nett cost of producing Zinc sulphate

$$Zn + H_2SO_4 = ZnSO_4 + H_2$$
$$65 + 98 = 161 + 2$$

∴ 65 grammes of Zn } form 161 of $ZnSO_4$
98 - - H_2SO_4 }

At the density of 1.0554, 100 grammes of ~~solution~~ contain 5.2 grammes of pure $ZnSO_4$ (anh.)

100 c.c. of solution weigh 105.4 grammes
∴ 100 . . . . contain 5.2 × 1.0554 grammes $ZnSO_4$
- 5.48 grammes pure anh. . .

1 gallon contains 4541 c.c. or 4541 × 5.48 . .
= 24.88 kg grammes pure $ZnSO_4$
= 0.5488 lbs.

161 grammes of Zinc require 65 of Zn = 98 of pure H_2SO_4
1 - - - - $\frac{65}{161}$ . . $\frac{98}{161}$ - - -
24.88 g. - - - . $\frac{65 \times 24.88 g}{161} = 100.5$ $\frac{98 \times 24.88 g}{161} = 151.6$

~~1 gallon~~
1 gallon contains 100.5 grammes of Zn and 151.6 grammes H_2SO_4
0.2215 lbs . . - 0.3342 lbs pure

1 lb. of Zinc requires 1 lb. of common Zn at 7½d per lb.
and 370 ampere hours of current at say 0.5 volt or
185 Watt hours = $\frac{1}{5}$ H.P. hours of electricity.
1 lb. of H_2SO_4 c.p. costs 12 c. actual or 15 cts here
1 H.P. hour costs 3 cts.

1 gallon contains 0.17 cents worth of current
2 cents worth of common Zinc
5 - - - H_2SO_4 pure.
0.5 - - - chemn, + reagents
7.67 -

The N.Y. price list gives 10 cts a gall for distilled water
+ 25 cts a lb for $ZnSO_4$ so that 2 gallon of
solution would be at this rate 10 + 0.5 × 25 = 23.8 cts
Things taken at 22c. cents per gall:
Prepared 8½ galls. of solution in carboy for Fall River Mass.

1 Standard cell @ 20.5°C 0.5t before obs:

135
135.9
135.6 ?
135.4

Mean 135.46 EMF 1.432

Mean temp. of room 22.4°C

1 Standard cell @ 23°.7C

136.3
135.8
135.0
136.1

Mean 135.8 EMF 1.428.

$$\mathcal{L} = \frac{d \times 0.715062 \times 5273 \times 10^3}{135.6 \times 46.57}$$

$$= 59.696\ d$$

Time	Volts	July 3rd Ohms	Lab.	Lockefeather dist Amperes turns	7.985 Ohms	Corrected	Mean	Co Lo
10.13	117.7	32 + 3pt	0.1	190.5	2.2	2.2	2.4	1143
.23	117.6		0.1		2.5	2.5		
.33	117.6		0.1		2.5	2.5		
.41	117	12 + 350	0.205	381	3.67	3.58?	4.13	2463
.45	116.9		0.2		4.0	4.0		
.52	116.9		0.2		5.8?	5.8?		
11.03	115.3		0.395	762	9.27	9.32?	9.04	5140
.07	114.3		0.392		9.1?	9.30?		
.12	115.7		0.40		8.5?	8.5?		
.22	116.3	105 x 10	7.50'	1905	23.4	23.2	22.6	13149
.27	116.5		7.50'		22.9	22.5		
.38	116.5		8.15'		20.2?	20.6?		
.44	117	78.89	11°.35'	2857	29.2	29.24	30.12	17799
.47	116.5		11°.35'		30.3	31.31		
.52	116.2		11°.35'		29.9	29.91		
12.21	115.9	57.09	15°.15'	3810	40	40.1	41.26	24163
.32	117		15°.15'		42?	42.1		
.41	107.3		14°.25'		39.5	42.0		
.47	116.2	44.72	18°.45'	4762	48	48.3	48.57	28999
.50	116.2		18°.45'		48.3	48.6		
.55	115.5		18°.45'		48.5	48.8		
14.07	116.5	26.35	22°.25'	5715	56.3	56.0	56.27	33591
.05	116.7		22°.25'		57.2	57.1		
.09	116.7		22°.25'		56.	55.7		
.22	118	27.23	28°.45'	7620	73	72.76	72.96	43355
.27	115.2		28°.40'		73.6	73.6		
.37	115.7		28°.40'		72.1?	72.1?		
.45	116.3	20.92	32°.15'	9525	83.8?	84.1?	83.84	50051
.52	115.6		32°.20'		83.7	83.76		
.58	115.8		32°.25'		84.	83.8		
15.06	115.7	17.38	39°.25'	11430	90	89.84	90.48	54402
.15	115.6		39°.30'		89.9	89.44		
.21	115.7		39°.20'		90.1?	90.11?		
.28	116.1		39°.25'		90.1	89.91		
.42	114.5	14.34	43°.15'	13335	96?	95.91?	96.71	5773
.49	114		43°.20'		97.8?	98.00?		
.56	114		43°.20'		95.9?	96.13?		
16.13	114.3		47°.50'		100.3	99.12	99.42	5735
.16	115.5	11.75	47°.40'	15240	100.9	100.51		
.19	114.0		47°.40'		98.9	98.42		
.26	115.9	9.4645	50°.40'	17145	106.3?	105.15?	104.09	6214
.30	113.6		50°.40'		103.1	103.64		
.34	114.0		51°.00		104.4	104.0		
.41	113.8	—	53°.20'	19050	107.5	107.4	107.52	6419
.50	113.8		53°.20'		107	106.9		
.58	114.1		53°.30'		107.8?	109.0?		

Wednesday 4th July

Two rubber covered wire completed to Engine Room. Insulation about 50Ω each and total res: including leads to first bottle about 4.92Ω

Thursday 5th July

Two glass tubes each 28 cm internal + 3.3 cm external diam, one 179.5 the other 174.5 cm. long were closed at their ends with plane glass disks cemented at the edge. About 9 cm from the ends, upright tubes about 1.5 cm in diam were blown into the main tubes, these were 23 or 24 cm. long and in the same plane. The solution employed was 10% H_2SO_4 in distilled water and about one litre was required to fill each.

Friday 6th July

Took down meters at 9.0. They had been at work since Monday 25th June 9.30. The current during that time has been on till about 23 o'clock except the 4th + 1st nights and one evening when current was reversed for 5 hours.

Tried the effect of the 120 volt dynamo on a dog – a fox terrier bitch. An alternator was first tried making 20 reversals per second, but owing to the screws in the instrument short circuiting the terminals, this failed. Therefore tried the direct current. The fore feet of the dog were lapped with damp cotton waste encircled with 2 or 3 turns of bare copper wire. The animal stood on the wooden engine room floor. On reaching an indicated potential of 1100 volts contact was made, for about 5 seconds. The animal writhed but uttered no yell till the contact was broken. Several fresh contacts killed it beyond question.

Weighed meter plates after washing them in distilled water and then drying by evaporation:—

Plate No.	Side	Weight 6.7.88	Joint weight 6.7.88	Weight 22.6.88	Joint weight	Gain	Loss	Diff. from Mean	% Error
1	~~B~~	22·6313	43·7222	21·2913	43·7062	~~0·2649~~	0·2084	0·0032	~~2·1%~~
2	~~B~~	21·2996	43·7219	22·4169	43·7062	0·2894	0·2084		
3	B	21·3367		21·1228			0·2139	0·0100	~~4·7%~~
4	A	21·8063	43·1438	22·0028	43·1276	0·2995			
5	A	21·4525	43·1430						
6	B	21·4764	42·9590	21·6859	42·9326	0·2278	0·2038	0·0002	0·09
7	A	21·4824	42·9595	21·2482	42·9329				
8	B	21·6566	43·1449	21·6872	43·1824	0·2289	0·1988	0·0051	~~2·5%~~
9	A	21·8671	43·1280	21·4277	43·1129				
10	B	20·6922	42·5588	22·0659	42·5332	0·2249	0·1988	0·0051	0·25
			42·5593	20·4673	42·5332				
11	C	20·5012	40·5783	20·2925	40·4863	0·2187	0·1960	0·0079	0·39
12	A	20·0072	40·5784	20·2032	40·4857				
13	C	21·7265	42·7600	21·5329	42·7356	0·2236	0·1985	0·0054	0·27
14	A	21·0038	42·7603	20·2030	42·7372				
15	A	21·1455		21·3636			0·2181	0·0122	0·56
16	B	21·3586	42·5043	21·1552	42·5194	0·2032			
			42·5061		42·5190				
17	C	20·9944	41·2212	20·7749	41·2087	0·2195	0·2089	0·0090	0·43
18	A	20·2266	41·2210	20·4355	41·2086				
19	B	22·1800		21·9550		0·2250			
20	A	20·1359	42·3162	20·3381	42·3331		0·2022	0·0017	0·08
			42·3169		42·3331				
						Mean	0·2039	0·006	~~2·9%~~

The red ink figures are the arithmetical means of each pair.
The mean error is thus 2·9%
These plates had not been fully amalgamated before this trial, and the large error is probably due to this.

Saturday 7th July

Took the Gauss magnetometer + apparatus with Llewellyn Park to determine H.

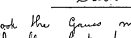
About 14·30 the silver watch was observed to be 18 secs slow by the clock.

Deflection observations as follow:—

Distance from mirror to scale 98·5" = 250·2 cm.

Torsion before observations $\frac{\pi}{2}$ clockwise 0·4 } 0·425
$\frac{\pi}{2}$ counter — 0·45

The mirror on the vibrating magnet is on the southwesting side.



Position of mag.	Mirror Magnet Towards	Deflection observed	Zero	Corrected Reading	a	b	c	d	a+b	a+b
a	in	+9·62		9·62	9·62				9·62	23·9
	out	−9·75	0·3+	19·05	−10·05				10·05	23·48
						Mean 23·69	Mean −23·445		9·75	23·8
d	in	−9·75		−9·75				−9·75	9·80	23·09
	out	+9·80	0·0	+9·80				+9·80	19·55	3·27
								Mean	9·805	23·59
b	out	−23·9		−23·9		−23·9				
c	in	−23·42	0·0	−23·8			−23·8			
c	out	+23·09		+23·09	Mean 9·775		+23·09			
b	in	+23·48	0·0	+23·48		+23·48		Mean 9·775		

Torsion after observations $\frac{\pi}{2}$ clockwise 0·45 } 0·435
$\frac{\pi}{2}$ counter do 0·42

Mean of all torsions 0·430.

Observed the period of the swinging magnet by four sets of observations as follows:

1st set swing 9.5 ±

No.	Transit		No.	Transit		No.	Transit		No.	Transit
0	16·8·31		44	14·17·8		141	76·26·5		187	45·42
1	8·45		45	·29		142	·13		188	·44
2	·56		46	·32		143	·29		189	·38
3	9·8		47	·44		144	·41		190	·30
4	·19		48	·55		145	·52		191	·57
5	·31		49	418·07		146	37·07		192	46·49
6	·43		50	·19		147	·15		193	·12
7	·55		51	·31		148	·29		194	·27
8	10·7		52	·43		149	·39		195	·34
9	·15		53	·56		150	·51		196	·39
10	·30		54	19·05		151	38·02		197	47·03
11	·43		55	·17		152	·14		198	·13
12	·56		56	·29		153	·26		199	·25
13	11·5		57	·41		154	·38		200	·36
14	·17		58	·52		155	·49		201	·48
15	·29		59	20·03		156	39·01		202	48·00
16	·40		60	·16		157	·13		203	·12
17	·52		61	·29		158	·24		204	·23
18	12·4		62	·40		159	·37		205	·36
19	·16		63	·51		160	·48		206	48·47
20	·27	Coefficient of 1/4 ″ = 2·87″ 2·37 ″ @ 11·8 2·23 ″ @ 11·8 224	64	21·03	Coefficient of 1/2 ″ = 9·02″ 7·67 ″ @ 11·72	161	·59	Coefficient of 3/4 ″ = 3·95″ 3·23 ″ = 9·93 ″ 24 ″ = 3·34 ″	207	

20 vibs in 236″ 11·8.

20 vibs in 235″ = 11·75.

20 vibs in 236″ = 11·70

64 vibs in 752 = 11·75.

161 in 1888 = 11·727

207 in 40′. 23″ = 2402·5″ = 11·720″ probably.

The correction for watch error 7″ in 18000 is 0·04″

= 2403·44″ = 11·724″.

Torsion obs: 8 ⅗ clockwise + 1·62 − 1·75 = −0·065 = −0·00
⅗ counter — 7 1·49 + 1·67 = +0·09 = +0·00
0 − 1·61 + 1·69 = +0·035

Mean 0·078 div.

Observations with 6 loaded magnet.
Temp 11.8°.5

No.	Transit				Transit
0	18·46			34	18·19·20
1	·5·21			35	
2	·5·47			36	20·11
3	–			37	20·36
4	–			38	21·03
5	~~7~~·30			39	21·28
6	·54			40	21·52
7	–			41	22·19
8	–			42	22·44
9	–			43	23·09
10	–			44	23·35
11	9·52			45	24·00
12	10·17			46	24·24
13	10·43			47	24·51
14	11·8			48	25·17
15	11·34			49	25·42
16	–			50	26·08
17	12·23			51	26·33
18	12·48			52	26·58
19	13·24			53	27·23
20	18·13·244			54	27·49

Lapse of 9 3.20.5" ÷ 25 = 13.01.
12.0 25.46 = 24.92
13.0 25.46 = 26.33

24 obs in 533·5
= 25·410
19 in 483
= 25·420
29 in 501 & 1 501
= 25·400

20 obs in 8' 29" = 509"
= 25·45

54 in 22'·53" = 1373" = 25·426"
50 · 24·17" = 1277 = 25·42

Taking 25·426 · Correction for watch error = 0·5" west
= 54 in 22·53·5 = 1373·5 = 25·435"

Torsion 0.	=	−6·33	+6·59		
		6·30	6·57		
	Mean	6·315	6·575	=	0·13 +
$\frac{\pi}{2}$ clockwise	=	+5·70	−10·0	=	2·15 − = 2·28
$\frac{\pi}{2}$ counter	=	+13·9	−8·5		
		+13·92	−8·7	=	2·06 + = 1·93
					Mean = 2·105

Scale distance = 72·75" = 184·8 error. Experiment ends at 18·32.

The mean time t' of one complete vib. of the loaded magnet being 25.426^s, the angle of torsion produced by $\frac{1}{2}$ is $\tan^{-1} \frac{2.105}{184.9}$ = log. 0.32225 − log. 184.9 = 2.26695 = 39′

$$\therefore t^2 = \frac{5439}{5400} \times (25.426)^2$$

log 25.426 = 1.405298
1.405298
· 5439 = 3.735591
6.546093
5400 = 3.732438
2.813655 = 651.2

$25.426^2 = 646.48$
$\times \frac{5439}{5400} = 651.15$

The mean time t' of one complete vib. of the unloaded magnet being 11.724^s, the angle of torsion produced by $\frac{1}{2}$ is $\tan^{-1} \frac{0.078}{184.8}$ = log 0.078 − log 184.8 = 2.89209 − 2.26639 = 2′

$$\therefore t^2 = \frac{5402}{5400} \times (11.724)^2$$

log 11.724 = 1.069098
1.069098
· 5402 = 3.732546
5.801644
· 5400 = 3.732432
3.138844 = 137.50

$(11.724)^2 = 137.452$
$\times \frac{5402}{5400} = 137.50$

The moment of inertia of the ring is 1087.3 so that the moment of inertia of the magnet is

$$\frac{137.5}{651.15 - 137.5} \times 1087.3$$

log 1087.3 = 3.036311
137.5 = 2.138328
5.174639
· 513.65 = 2.710673
= 291.06

$= 291.06$

By laboratory measurement the moment has been 287.

The time of oscillation being $\sqrt{137.5}$

$$MH = \frac{4\pi^2 \times 291.06}{137.5}$$

log π^2 = 0.994299
10 = 0.602060
· 291.6 = 2.464908
4.060448
· 137.5 = 2.138328
= 83.568

$= 83.568$

Accepting I at 287.0

$$= \frac{4\pi^2 \times 287}{137.5}$$

$4\pi^2$ = 1.596399
287 = 2.457882
4.054281
· 137.5 = 2.138328
= 82.40 1.918292

$= 82.402$

The corrected deflections are

$\frac{5400+v}{5400} \times 9.805$ and $\frac{5400+v}{5400} \times 23.57$

Where $v = \tan^{-1} \frac{0.43}{250.2} = \frac{2.3}{2.502} \times 10^{-3} = 1.719 \times 10^{-3} = 6'$

$\log .43 = \bar{1}.633247$
$-\ \log 2.502 = \bar{3}.398724$
$\bar{3}.235518 \quad .6'$

$\frac{5406}{5400} \times 9.805 = 9.8157$

$\log \frac{5406}{5400}$ 0.000484822
9.8157 0.991464776
0.992949598 pr.157

$\frac{5406}{5400} \times 23.57 = 23.596$

23.57 1.372339 6
0.000484822
1.372824818 23.596

$\tan^{-1} \frac{9.816}{250.2} = \log \frac{9.816}{250.2} =$ 0.991929 9
2.398287 3
2.603642 5
6006767
.0029658 177986 .56
31619 19823

$\sin = 2907'.15 = 193 = 0.040011 25$

$\tan^{-1} \frac{23.596}{250.2}$ $\log \frac{23.596}{250.2} = 1.372839 24 - 2.398287 3 = 2.974551 1 =$
$5^\circ 23' 15''$
$\sin = 8.972730 0$ $\frac{974 2 - 72}{13,500} \quad \frac{3272 \times 60}{13,500} = 20.14$

$\sin = 0.093891 1$

$x = 50$
$x_1 = 37.5$

$$P = \frac{\frac{1}{2}(50)^2 \times 0.040113 - \frac{1}{2}(37.5)^2 \times 0.09389}{25 \times 0.040113 - 18.75 \times 0.09389}$$

$$= \frac{62500 \times 0.040113 - 26,367 \times 0.093891}{} = \frac{2507.0625 - 2475.6266}{1.002825 - 1.760458} = \frac{21.4359}{-0.757763}$$

$= -28.3$

$$\frac{M}{H} = \frac{(50)^3}{2} \times 0.040113 \times \left(1 + \frac{28}{2500}\right)$$

$$= \frac{62,500 \times 0.040113 \times 2528}{2500}$$

$$= 25 \times 0.040113 \times 2528 = 2535.1$$

$$\frac{M}{H} = \frac{(37.5)^3}{2} \times 0.09389911 \times \frac{2528}{2500}\left(1 + \frac{28}{1400.3}\right)$$

$$26,367.2 \times 0.09389911 \times 1.0112 = 2525.2$$

---

log $\frac{M}{H}$ = 1.915929 2 log $\frac{M}{H}$ 1.922032 1

$\frac{M}{H}$ = 3.403120 5 — 3.403120 5

5.319904 97 — 5.325 1526

2.658952 48 = 456.09 — 2.662576 3 = 459.81

1.915929 2 — 1.922032 1

T 2.564044 4 = 0.1805 — T 2.592588 = 0.1817

but

Moment of magnet 456.6. ! probable T 26°C

it was 443.4 on 28th from T 29°C

460.6 - 30th April T 22°C

Monday 9th July

Found a short circuit in the left hand limit of the pendulum electromagnet. Between the 2nd & 3rd fingers from the bottom.

Set the 3 Roberts-Beaumont primary cells to work again through 0.5Ω but found that there was not enough solution left in the carboys to fill more than two properly, so that the third was run on less than half solution. These cells are numbered 1 2 & 3. No 2 is the efficient cell.

Also set the 3 Mason primary cells to work through 0.5Ω stranded platinoid wire. As one of these (No 4) had two carbons and a wider carbon head it is possible that it may have been short circuited by accident for has been below commencing. Numbers 4 5 & 6

The weight of the zinc plates in the cells were before starting.

No	Plate No.	Weights oz	grm	Plate No.	Weights oz	grm
1	1	56.13	1592	2	53.75	1524
2	3	55.13	1563	4	56.25	1595
3	5	53.20	1508	6	54.25	1538
4	5	82	2325	6	83.5	2367
5	2	82.25	2332	4	77.75	2204
6	1	81.5	2310	3	82.6	2341.2

The cells were set to work at 15.30

Tried the new Edison voltmeter. Found it to be very sensitive and to have a range of about 7 volts with 1 ampere traversing it.

(1)

Date	Hours	EMF	C	R.
15·30	97 0	2·180	4·016	0·044
16·00	" ½	2·121	2·528	0·101
16·30	" 2½	2·073	3·456	0·100
17·00	10·7 15½	2·034	3·538	0·072
17·30	" 28	2·025	3·572	0·064
18·00	11·7 43	2·009	3·574	0·058
18·30	" 53½	1·998	3·598	0·071
19·00	12·7 67½	1·956	3·600	0·068
19·30	" 76½	1·922	3·606	0·070
20·00	13·7 91	1·818	3·620	0·081
20·30	" 100½	1·706	2·932	0·081
21·00	14·7 115½	1·576	2·372	0·079
21·30	" 123	1·488	1·892	0·075
22·00	15·7 138½	0·966	0·820	0·068
22·30	" 172	0·446	0·796	0·069

Circuit broken

(2)

Date	Hours	EMF	C	R.
15·30	97 0	2·168	3·320	0·035
16·00	" ½	2·036	2·184	0·051
16·30	" 2½	2·027	1·806	0·0624
17·00	10·7 15½	2·025	1·230	1·142
17·30	" 28	2·015	1·425	0·913
18·00	11·7 43	1·982	1·578	0·7001
18·30	" 53½	1·830	1·664	0·673
19·00	12·7 67½	1·650	1·432	0·785
19·30	" 76½	1·422	1·564	0·746
20·00	13·7 91	1·316	1·476	0·798
20·30	" 100½	1·240	1·496	0·770
21·00	14·7 115½	1·186	1·484	0·770
21·30	" 123	1·038	1·476	0·745
22·00	15·7 138½	1·652	1·552	0·552
22·30	" 172	1·562	1·004	1·006

Circuit broken

(3)

Date	Hours	EMF	C	R.
15·30	97 0	2·180	3·360	0·113
16·00	" ½	2·128	2·480	0·115
16·30	" 2½	2·056	3·382	0·111
17·00	10·7 15½	2·034	3·492	0·072
17·30	" 28	2·020	3·524	0·070
18·00	11·7 43	2·027	3·576	0·076
18·30	" 53½	2·000	3·588	0·072
19·00	12·7 67½	1·980	3·596	0·079
19·30	" 76½	1·834	3·344	0·085
20·00	13·7 91	1·352	2·100	0·090
20·30	" 100½	1·733	2·980	0·056
21·00	14·7 115½	1·570	2·332	0·057
21·30	" 123	1·478	1·934	0·058
22·00	15·7 138½	0·860	0·816	0·088
22·30	" 172	0·441	0·788	0·086

Circuit broken

The total No. of Joules = 375,590
External 257,300
Total 632,890
607 Gramme-Zinc used =
= 4766 Joules per gm.

Internal Total Joules

Internal Total Joules

(4)

Date	Hours	EMF	C	R.
15·30	97 0	2·054	3·972	0·025
16·00	" ½	2·018	3·372	0·099
16·30	" 2½	2·020	3·426	0·090
17·00	10·7 15½	2·000	2·476	0·146
17·30	" 28	1·980	1·568	0·207
18·00	11·7 43	1·620	0·788	0·322
18·30	" 53½	0·910	0·720	0·069
19·00	12·7 67½	0·605	0·670	0·107
19·30	" 76½	0·598	0·640	0·1312
20·00	13·7 91	0·586	0·592	0·131
20·30	" 100½	0·576	0·580	0·143
21·00	14·7 115½	0·570	0·560	0·157
21·30	" 123	0·562	0·528	0·148
22·00	15·7 138½	0·556	0·5844	0·5833
22·30	" 172	0·510	0·496	0·529

Circuit broken

(5)

Date	Hours	EMF	C	R.
15·30	97 0	2·092	3·732	0·061
16·00	" ½	1·968	3·486	0·068
16·30	" 2½	1·949	3·406	0·072
17·00	10·7 15½	1·852	2·972	0·126
17·30	" 28	1·792	2·640	0·130
18·00	11·7 43	0·988	1·432	0·187
18·30	" 53½	0·676	0·896	0·244
19·00	12·7 67½	0·644	0·796	0·316
19·30	" 76½	0·572	0·688	0·331
20·00	13·7 91	0·521	0·624	0·306
20·30	" 100½	0·526	0·606	0·347
21·00	14·7 115½	0·526	0·588	0·346
21·30	" 123	0·510	0·520	0·379
22·00	15·7 138½	0·478	0·524	0·412
22·30	" 172	0·452	0·524	0·420

Circuit broken

(6)

Date	Hours	EMF	C	R.
15·30	97 0	2·101	3·824	0·121
16·00	" ½	2·0122	3·824	0·1141
16·30	" 2½	2·045	3·302	0·131
17·00	10·7 15½	1·890	3·112	0·107
17·30	" 28	1·746	2·704	0·133
18·00	11·7 43	1·322	1·332	0·3377
18·30	" 53½	0·722	0·828	0·376
19·00	12·7 67½	0·612	0·672	0·410
19·30	" 76½	0·570	0·632	0·433
20·00	13·7 91	0·555	0·594	0·439
20·30	" 100½	0·570	0·576	0·479
21·00	14·7 115½	0·570	0·558	0·521
21·30	" 123	0·566	0·560	0·511
22·00	15·7 138½	0·566	0·500	0·632
22·30	" 172	0·550	0·500	0·600

Circuit broken

(7)

Date	Hours	EMF	C	R.
15·30	97 0	2·054	3·972	0·025
16·00	" ½	2·018	3·372	0·099
16·30	" 2½	2·020	3·426	0·090
17·00	10·7 15½	2·000	2·476	0·146
17·30	" 28	1·980	1·568	0·207
18·00	11·7 43	1·620	0·788	0·322
18·30	" 53½	0·910	0·720	0·069
19·00	12·7 67½	0·605	0·670	0·107
19·30	" 76½	0·598	0·640	0·1312
20·00	13·7 91	0·586	0·592	0·131
20·30	" 100½	0·576	0·580	0·143
21·00	14·7 115½	0·570	0·560	0·157
21·30	" 123	0·562	0·528	0·148
22·00	15·7 138½	0·556	0·5844	0·5833
22·30	" 172	0·510	0·496	0·529

Circuit broken

Internal Total Joules
External -
178,860
493,300
672,160

546 grs Zn consumed
= 1232 Joules per gr.

Internal Total Joules
External -
202,460
730,100
932,560

524 grs Zn consumed
= 1780 Joules per gr.

Internal Total Joules
External -
257,900
705,700
963,600

521 grs Zn consumed
= 1850 Joules per gr.

Faulty pendulum limit recovered with inlet paper between the layers.

1st layer 199 turns
2nd " 194 "
3rd " 189 "
4th " 191 "
5th " 181 "
6th " 74 "

Total 1028. Previously 1057.

Res: = 2.469 Diam external over paper 10 cm.

Physiological effect of shock—

Two dogs for experiment.

1st Small black mongrel:

Parcelled one fore leg and the opposite hind leg with wet cotton waste wrapped with wire. Res: between these wires about 7500 by bridge.

800 volts from Municipal machine applied direct for about 2 sec to dog as it rested on rubber sheeting. Current commenced at 1/10 amp: ended at 1 amp:

22 beats. Result. fatal after some minutes.

2nd dog light tawny animal of greyhound extraction. Parcelled as above. Res: about 8500.

Direct current from 290 volts given for one second. 1/4 amp indicated current. Result not fatal. Dog not much hurt.

Current then alternated at same voltage 11 turns per sec: Contact made for 2 sec. Result not fatal but dog much debilitated for several mins:

Current then alternated 47 turns per sec at 800 volts pressure. Contact for 3 sec: Result fatal in less than half min.

Wednesday 11th July.

Raw Plating Dynamo at 11.45.
1090 revs per min = 28 feet per sec. EMF 4·6 volts

Thursday 12th July.

Tested 5 dynamo circuit which does not giving satisfactory results as follows. only 7 oz Wattsville of zinc per hour. on 15 cathodes

Res: of leads down to engine room plighboard 5·169 ω.

Res to the Chemical room junction with the 3 wire cable 5·182 or 0·013 ω

Res to the baths in the plating room at end of cable 5·190 or 0·021 or 0·008 ω in 3 wire cable

Res: including one bath 5·250 = 0·060 ω in one bath.

Current would be with 3 in series
4·5 ÷ 0·200 = 22·5 amperes.
actually 33 amperes were obtained.
The leads are 216 feet long from the plighboard to the junction with the cables in the chemical room. that is 432 feet of conductor (say 400 feet of it as the engine room part is of much larger area) made up of two rods ½" diam = 0·00004014 ω per foot
= 0·016 ω ÷ 2 = 0·008 ω

Physiological experiments.

Hands wiped dry and brought in contact with two terminals in connection with the municipal dynamo whose potential diff was deduced to be 1200 by voltmeter. Strong shock felt with muscular contractions in elbows and principally on breast. Diggy connection allied to syncope for the minute. Contact with terminals only momentary. Temporary debility lasting for a few minutes and headache followed. Two small blisters that if in doubt at point of contact the two small blisters that if in doubt at point of contact the point on the body just of the thumb right hand, — point on the outer edge of the pillow letter in the drafts.

Copper wire data.

1 mil foot is stated to be on Mathiessen's authority 9.718 B.A. ω @ 0°C

= 9.610 Legal ohms @ 0°C

= 10.527 " " @ 75°F or 18°C

@ 90% purity this becomes

11.7 " "

The diameter of the copper leads to the Chemical building is 0.635 so that its circular mils are 403,225.

$11.7 \div 403225 = 11.7 \div 4.03 \times 10^5 = 2.90 \times 10^{-5}$ per foot

$= 1.45 \times 10^{18}$ per foot 2 together + there are about 400 feet. $580 = 5.80 \times 10^{-3} = 0.0058\omega$

There are about 80 feet of cable 160 in all of 3 wires each 0.203 or 412,1000 c. mils $= 2.83 \times 10^{-10}$

$= 0.000283$ or 0.000009ω per foot jointly

$= 9.4 \times 10^{-10} \times 160 = 0.00\cancel{1}4$

The res: in cct: should be in Dynamo connection 0.001

Leads to Chemical room 0.008

" beyond 0.007

0.011

3 baths in multiple 0.015

0.026

= 200 amperes

3 baths in series 0.135

= 30 amperes

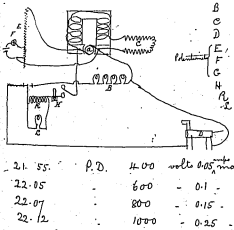
Physiological Experiments. 12th July

Before Mr H. P. Brown & in the presence of Dr Peterson nerve specialist of the Vanderbilt Clinic Hospital.

Dog no 3. Fox terrier bitch
Length tip of nose to base of tail 24"
Height 13"
Weight 13½ lbs.
Resistance 6000 – (about)

Wet cotton waste bandages were applied in the ordinary way to the opposite fore & hind legs. (rt fore & left hind) These were wrapped over with copper wire.

Connections as follow—



a Municipal armature
B lamp bank of 12 lamps
C Controlling field rh.
D Dog
E, F Electrodes { E, fore – Cathode. F – hind – Anode
G Daylight cell or cells
H Ammeter.
R Phelps relay
L 32 cp. lamp shunt.

21. 55. P.D. 400 volts 0.05 amp momentary direct current, not fatal
22.05 – 600 – 0.1 – – – – – –
22.07 – 800 – 0.15 – – – – – –
22.12 – 1000 – 0.25 – – – – – –

1000 volt momentary current fatal in 2 mins.

Dr Peterson then dissected. The animal's heart continued to beat until 22.50 when it was cut out. The muscles also were in automatic twitching for a considerable time. He removed parts of the sciatic and nerves also part of the cords spinal cord for microscopic examination.

2nd bird. Dog no 4.
Half bred. bull dog
Length tip of nose to base of tail 37"
Height 21"
Weight 46½ lbs.
Res: 11,000 ω

Alternated current 2200 times per min = 36·7 per
23.22. 800 volts Current in amperes 0·1 amperes Contact
2½ secs. Result fatal in 15 secs.

Res: of Mr Brown @ follows
(1) Standing on brass plate as one electrode on dry floor and holding a brass connecting screw in his dry hand as the other electrode. Res Z 180,000 ω.
(2) Hands moistened and plate wet, but boots still dry Z 178,000.
(3) Bare right foot on wet plate, sitting position + right hand holding wet towel compressing binding screw
Z 7320
C more say 7500.
(4) A terminal in each hand held in wet towels. Z } 19,090 ω
C }
(5) Wet towels and terminals on backs of hands under pressure of knees
Z 15,500
C less.

My own res: between hands, holding terminals in wet towels like (no 3) above
Z 5580 ω
measured by Mr Brown

1 Standard cell @ 21.9°c through 0.5 t

136.1
137.7 ?
136.6 ?
137.0 ?
136.7

EMF 1.430

Mean temp. of room 23.5°c.

After observations

136.3
136.8
136.3
137.1
136.7

@ 25.9°c = 1.426

$$L = \frac{d \times 0.71465 \times 5294 \times 10^{-6}}{136.25 \times 46.57} = 59.626$$

Time	Volts	Interpolation Phase	Dist Ind. C.	20 mm Magnet Amplitude	11.h Phase	Polar 33 Corrected	Means	L
10.25	115.7		0.0995	187.6	5.9	5°.93	6.072	362
.33	116.6		0.10		6.3	6.00		
.42	116.2		0.10		6.55	6.50?		
.53	118.2		0.201	375.2	11.7	11.64	11.38	679
.59	117.2		0.20		11.4	11.40		
11.07	116.1		0.1995		10.87	10.83?		
.07	116.7		0.4	750.4	23.7	23.?	22.56	1345
.11	116.3		0.403		22.3	22.1		
.14	116.8		0.40		22.8	22.8		
.26	115.2		7°.45'	1876	54.4?	54.7?	57.32	3418
—	116.2		—		59.1?	57.4?		
13.23	115.9		—		58.9?	57.1?		
.37	117.0		7°.50'		58.1	57.1		
.50	116.4		11°.15'	2814	80.1	82.6	81.83	4879
.57	119.3		11°.30'		80.4	81.0		
14.07	113.7		11°.20'		80.0	81.9		
.09	116.2		15°.30'	3722	105?	103.5?	102.93	6138
.16	116.2		15°.35'		104.8	102.7		
.18	115.5		15°.30'		104.8?	102.9?		
.32	115.5		18°.45'	4690	121.2	122.0	122.38	7297
.35	117.2		18°.55'		122	121.6		
.43	116.9		18°.25'		122.1?	122.3		
.50	115.9		22°.25'	5528	136	135.2	134.78	8036
.54	116.2		22°.30'		136.2?	134.9		
15.07	115.9		22°.30'		135?	134.3		
.14	115.9		28°.30'	7,506	148.2?	148.7?	149.93	8939
.22	115.9		28°.20'		148.2?	150.3		
.27	115.9		28°.30'		149.7?	150.8		
.33	116.3		34°.20'	9380	156.6	158.7	156.84	9352
.36	115.0		34°.20'		157.9	159.0		
.40	116.0		34°.35'		158.4?	158.8		
.47	116.0		39°.20'	11,256	161.?	161.1?	161.93	9655
.56	119.2		39°.25'		162.4?	162.0?		
.57	115.9		39°.30'		163.5?	162.7?		
16.01	115.2		43°.35'	13,132	167	167.9	170.07	10,141
.07	111.2		42°.25'		166.5?	172.3		
.11	113.2		42°.30'		166.9?	172.2		
.20	113.0		47°.35'	15008	171.2	178.8	173.33	10335
.23	115.8		47°.35'		170.3	170.2		
.29	112.0		46°.45'		169.	173.9		
.33	110.0		50°.30'	16984	173.4	175.9	176.97	10,552
.36	109.9		50°.15'		172.5	177.6		
.41	115.0		50°.50'		176.7	177.4		
.47	115.7		53°.35'	18760	177.1?	178.6	180.55	10,765
.54	113.2		53°.25'		177.2	179.8		
.57	112.1		52°.45'		177 ?	182.0		

1 Standard cell 0.5 f

21.5°C { 121.7, 121.5, 121.9, 122.0 } EMF 1.430

Mean 121.78

Mean temp. of room 21.9° C.

After observations.

21.5°C { 121.6, 121.8, 122.1, 122.0, 121.7 } EMF 1.431

Mean 121.84

$$\mathcal{L} = \frac{d \times 0.7153 \times 5264 \times 10^2}{121.81 \times 46.57} = 66.55\,d.$$

Time	Volts	Interpolar Ohms	Diet Ind. B	1.5 ohms Amperes	12.5 Thrust	Field Corrected	Adjusted Mean	$\mathcal{L}$
10.21	118.7		0.1005	187.6	6.9	6.866		
.28	119.8		0.101		5.7	5.644	5.905	398
.34	119.2		0.101		5.5	5.448		
.41	118.1		0.20	375.2	11.3	11.3		
.44	119.1		0.20		11.1	11.1	11.33	754
.50	117.2		0.1995		11.8?	11.83		
.55	117.3		0.399	750.4	23.07	23.06		
11.00	117.5		0.40		22.4	22.40	22.65	1507
.03	118.0		0.40		22.7	22.70		
.19	118.3		7°.45'	1876	59.4	59.66		
.22	117.5		7°.45'		59.4	59.46	59.62	3968
.26	117.2		7°.45'		59.6?	59.86		
.39	116.9		11°.20'	2.814	85.8	85.2		
.42	113.9		11°.25'		84.9	86.2	85.32	5678
.54	117.5		11°.25'		83.8?	83.8?		
12.17	117.2		15°.20'	3752	105.5	105.2		
.22	116.5		15°.15'		106.1?	105.3	105.9	7048
.29	116.3		15°.15'		106.0	106.4?		
.34	116.8		18°.50'	4690	121.2	121.4		
.42	116.9		18°.45'		121.4	121.3	121.6	8093
.46	117.1		18°.50'		121.1	122.0		
.54	117.0		22°.18'	5628	133.2?	133.2?		
.58	116.8		22°.20'		132.9?	132.7?	132.62	8824
13.25	116.8		22°.22'		133.1	132.3		
.31	117.0		25°.35'	7504	142.9	143.4		
.47	116.1		25°.35'		143.1	143.6	143.56	9554
.55	116.3		25°.35'		143.3?	143.3?		
15.00	115.9		34°.17'	9380	150.2	150.6		
.04	116.4		34°.15'		150.9	151.5	151.1	10056
.09	116.8		34°.15'		150.9?	151.3		
.21	116.8		39°.20'	11,256	157.8	157.9		
.26	115.8		39°.15'		156.2	156.8	156.87	10440
.31	117.8		39°.25'		158.3	155.9		
.36	115.9		43°.20'	13,132	161	163.3		
.42	116.2		43°.25'		162	163.8	163.12	10856
.45	115.6		43°.20'		162?	161.4		
.50	115.3		47°.20'	15008	165	164.4		
.57	116.3		47°.30'		164.4?	164.7	165.78	11,033
16.01	115.1		46°.45'		166.9?	169.6?		
.13	116.3		50°.10'	16,884	167.4?	171.8		
.17	116.0		50°.20'		168.1?	168.5	169.32	11,270
.27	116.5		50°.25'		168.5	168.5		
.33	115.9		54°.00	18,760	171.4?	170.2		
.39	116.7		53°.40'		171.2	170.4	171.56	11,418
.42	116.6		53°.45'		172	172.4		
	Diet.	between	poles	1.4.7 and 1.5	when when	current broken	10 amperes	

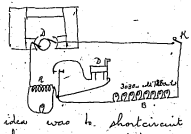
Physiological Experiments continued :— 14th July,

In the presence of Mr Brown + of Dr Peterson

Dr Peterson said that he had somewhat hastily examined under a microscope the ~~nerves~~ of sciatic + inferior cervical nerves of the legs of dogs 3 + 14 which took the current on the 12th inst: and that he found in the case of dog no 3 which had the direct current a considerable degree of pathological alteration in the medullary sheath which had become to a certain extent granulated resembling the morbid condition of nerve disease. The primitive membranes also were congested. In the case of the dog no 14, which had received the alternated current, this condition of the nerve was not evinced, but there was more pathological alteration and destruction of the nervous tissue generally than in the case of no. 3.

Dog # 5. Half bred shepherd specie. Weight 50lb. Height 23½ in. Length 39. Res: abt 6000.

Arranged connection as shewn:—



D Dynamo
K Key
B Bank of 8 lamps
R Relay shunted by 32cp lamp
D Dog.

The idea was to short circuit the dog by the relay lever as soon as it moved over after the delivery of a very short current, and thus and any

21.40 Volts 1000 0.10 ampères. Dog yelped once but not much hurt. Respirations immediately afterwards 120 per min.

21.44 Volts 1100 0.20 ampères. Dog yelped once but not much hurt. Resp: after 72.

21.46 Volts 1200 0.30 ampères. Dog yelped once but not much hurt. Resp: after shock 72.

21.51 Volts 1300 0.20 ampères Dog yelped once but not much hurt. Resp. after shock 60

21.53 Volts 1400 0.30 ampères Dog yelped once but not much hurt. Resp. 72.

21.57 Volts maximum 1420 0.20 amp. Dog yelped once but not much hurt. Resp. 72.

Res: of dog now taken again, and animal examined. He was much excited but otherwise uninjured. Res: about 6500.

It was now decided to give more than the above about current. It is obvious that the above potentials were based on the dog itself by at least $\frac{128000}{72.20} = 17\%$ and possibly as much as $\frac{30000}{9000} = 33\%$ owing to the interposition of the lamps in the circuit, and secondly the inductance of the armature diminishes the momentary current on first making contact.

Dog connected up again as before, bandages of copper wire on wet cotton waste on opposite leg to fore + hind leg. Resp: 152 per min.

22.30. 1200 volts 0.30 amp. 2½ secs: contact before releasing armature:

Dog yelped once but not much hurt.

Resp: 112.

Dog now released for examination.

The P.D. on the dog in this case must have been about 1000 and the calculated current 0.17 amp.

Dog #6 Black mongrel - Weight 55 lbs (80.)
Length 35"
Height 21".
Res: 3600.

alternating current 4100 turns per min
= 68·3 - - sec.

Resp. before application 1234 per min.
Lamp in multiple with dog acting as load
3.02 300 volts - alternating - contact 2 secs:- 0·1 amp.
Dog howled for about 1 min & struggled violently. Resp. 54 to 30 very variable.

22·21 400 volts alt. 2 secs.
Dog yelped and struggled. Resp. 168.

22·25 500 volts alt. 2 secs.
Dog yelped and struggled Resp. 170.

22·31 600 volts alt. 3 secs.
Dog yelped and groaned. Died in 90 secs.
Voltage fell during experiment being 540
one minute afterwards so that the true voltage at the time of delivery was probably alt. 570

Dog dissected by Dr Paterson.
Blood healthy. Muscles very irritable
Heart not beating but very irritable.
Much liquid dark venous blood.
Microscopic examination of blood did not indicate anything abnormal.
Part of sciatic nerves removed from each leg and from one fore leg.

To find the dimensions for a dynamo to supply v volts on the Faraday principle. Suppose the strength of field to be 5000 lines per sq. cm. Then if l be the length of the cylinder and r its radius then its circumferential speed at a known rev. of 1500 ft per min. is $\frac{1500 \times 30.48}{60 \times \cancel{\ldots}} = \frac{760}{\cancel{\ldots}}$

Consequently the area it will describe per sec. is $\frac{760 \pi l}{\cancel{\ldots}}$ and the voltage will be

$$v = \frac{5000 \times 760 \pi l}{\cancel{\ldots}} = \frac{3{,}760{,}000\, l}{\cancel{\ldots}} = v \times \cancel{\ldots}$$

$$\therefore \frac{l}{\cancel{\ldots}} = \cancel{\ldots} \; 26.6\, v.$$

The new Edison voltmeter exerts a pull of 0.75 grammes = 735 dynes when supplied with 1 ampere and has a range of about 3 volts on each side of 0 under those circumstances. When supplied with 0.75 amperes its pull is 0.28 grammes or 274.4 dynes. Its range is then fully 5 volts each side of the zero.

Monday 16th July

Took following observations of spring elasticity in the new Absolute Electrometer — Temp 33°C arbitrary. fiducial mark made of g.s. wire in beacons on bridge in absence of cover to read scale on top screw.

Instrument placed in hole slot and plane. The lower plate levelled, the upper plate brought parallel, and the moving plate adjusted to come to fiducial mark when in plane of upper guard plate.

	Reading		Difference
No weight		0810	
0·6 grammes		3330	2530
No weight		0804	
0·6 grammes		3370	2566
No weight		0804	
0·6 gr.		3316	2516
No weight		0805	
0·6 gr.		3375	2570
No weight		0805	
0·6 gr.		3365	2560
No weight		0805	
0·6 gr.		3372	2567
		Mean	2552

When cover in its place the zero reading is 0795 so that the selected reading is to be 3347. say 1335. This corresponds to the pull of 06 grammes weight. This weight was distributed fairly in ~~det~~ grammes weights over the surface of the plate.

1 Standard cell Temp. 20.3°C. through 0.5t

122
122.6
122.3 ?
122.7 ?

EMF 1.4322

Mean 122.37

Mean temp: of room 23.15°C.

After observation

122
121.2 ?

T. 23.62. 121.5
121.3
121.9

EMF 1.4284

Mean 121.62

$$L = \frac{d \times 0.71515 \times 5288 \times 10^{-}}{121.995 \times 46.57} = 66.5624$$

Interpolar dist. 1. 4m. 12.5 Indy BR

Time	Volts	Ohm	Ind. B.	Amperes	Shunt	Corrected	Adjusted	B
7.42	115.9		0.1005	187.6	7.3	7.26	7.42	492
.44	115.2		0.1		7.2	7.2		
.53	116.9		0.1		7.2	7.2		
8.17	115		0.2	375.2	14.2 ?	14.2 ?	14.140	959
0.13	115.8		0.2		14.8	14.8		
.27	116		0.2		14.1	14.1		
.17	116		0.4	750.4	28.8	28.8	28.43	1892
.22	115.8		0.399		28.1	28.17		
.35	115.6		0.397		28.1	28.31		
.37	116.5		7°.40'	1876	74	73.68	73.8	4912
.46	116.2		7°.40'		73.7	73.38		
.56	115.5		7°.40'		73.2	72.83		
11.39	115.9		11°.35'	2814	101.7	101.7	102.3	6809
.42	117		11°.35'		102.3	102.3		
.46	115.0		11°.35'		103.0	103.0		
.53	118.0		15°.15'	3752	126.3	125.6	126.9	8447
.57	113.		15°.00		125	124.5		
12.20	117.3		15°.10'		125.7	125.5		
13.22	118.2		18°.50'	4690	140.7	140.14	140.58	9358
.26	118.2		18°.50'		140.6	140.9		
.27	117.3		18°.50'		140.0 ?	140.3 ?		
.32	117.0		22°.20'	5528	114.9 ?	118.7 ?	119.0	9915
.42	117.		22°.20'		115.8 ?	118.8 ?		
.50	117.2		22°.20'		159.1 ?	119.8 ?		
.55	117.0		25°.40'	7502	160.3 ?	160.3 ?	159.9	10,644
14.00	117.6		28°.35'		159.4 ?	160.0		
.03	116.5		28°.35'		158.9	159.5		
.14	117.		34°.20'	9380	167.7 ?	167.8 ?	166.78	11,101
.13	117.		34°.20'		167.0 ?	167.1		
.23	117.2		34°.20'		166.4	166.2		
.28	117.		39°. 05'	11,256	171.2	172.9	172.68	11491
.36	116.1		39°. 15'		171.9	172.5		
.40	116.9		39°. 10'		171.3	172.5		
.48	115.9		43°.35'	13,132	175.6	176.6	176.44	11,742
.52	115.7		43°.35'		176.0	177.0		
.56	117.6		43°.50'		176.1	176.5		
15.01	113.8		47°.30'	15,008	179.5 ?	179.9 ?	180.18	11,994
.07	116.5		47°.30'		179.2 ?	179.6 ?		
.10	115.3		47°.25'		180.3	181.2		
.20	114.0		50°.40'	16,814	182.9	184.14	183.2	12,195
.24	114.5		50°.40'		181.2	182.7		
.30	115.5		50°.00		183.1	182.4		
.34	115.8		53°.55'	18,760	185.8 ?	185.0	186.7	12,427
.38	114.7		53°.40'		186.9 ?	187.9		
.43	116.6		53°.35'		185.4	187.0		

Interpolar dist. at last current 0.965 after breaking

cut 1.0

Tuesday 17th July.

Took out zinc plates from the primary battery and weighed them as follows.

Cell No.	Plate No.	Weight 9.7.88 oz.	Weight 17.7.88 oz.	Loss oz.	Weight 9.7.88 grs.	Weight 17.7.88 grs.	Loss grs.	Cell Loss grs.
1	1	56·13	45·75	10·38	1592	1297	295	
	2	53·75	42·75	10·00	1524	1212	312	607
				20·38				
				578 g.				
2	1							
	2	56·25	43·50	12·75	1595	1233	362	362
3	1	58·20	47·75	10·45	1650	1354	296	
	2	54·25	42·75	11·50	1538	1212	326	622
				21·95				
				622 g.				
4	1	82·0	69·5	12·5	2325	1970	355	
	2	83·5	76·75	6·75	2367	2176	191	546
				19·25				
				546 g.				
5	1	82·25	73·	9·25	2332	2070	262	
	2	77·75	68·5	9·25	2204	1942	262	524
				18·5				
				524 g.				
6	1	81·5	68·0	13·5	2311	1928	383	
	2	82·6	77·75	4·85	2342	2204	138	521
				18·35				
				520 g.				

The Roberts-Austen cell has zinc 6" × 13" 33 × 1524 Liquid rise 4 1/2" 30·5 cm.

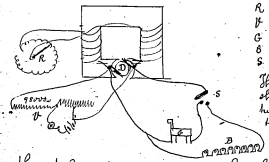
The Moore Wood cell has zinc 6" × 13" 33 × 1524 Liquid rise to 9" 22 cm.

The 5 volt dynamo charged from the 130 volt circuit gives 5.1 volts @ 1676 revs. per min.

The first 4 Barrett Apple give EMFs applied at 23°c.

No 1.	1.026	volts
" 2	1.030	"
" 3	1.031	"
" 4	1.031	"

Physiological Experiments continued :—



D. Dynamo
R Field Resistance
V Voltmeter connection
G Dog
B Lampbank 12 lamps
S switch.

The arrangement shown that in turning the switch towards the right contact is first made through the dog and subsequently through both dog and lampbank which finally the lamps only are left in circuit so that when the circuit is completed broken any discharge from the inductance of the armature will have passed through the lamps and not through the dog.

Mr Brown not present at this experiment.

A foucault interrupter beating 62 times to the minute was used to give time for contact

Dog #7 Yellow mongrel.
Length tip of nose to base of tail 28½"
Height at shoulder 18"
Weight 35 lbs.

Res: between usual bandages on legs 20,000ω.

22.15 Direct current applied to dog between right fore and left hind legs: 500 volts EMF current observed 0.025 ampere.
Calculated value $\frac{500}{20,000} = 0.025$ also.
duration of contact at switch S = 4 secs.
The dog yelped once while current on, and howled afterwards, but died within a minute.

22.22 Carcass thrown into furnace.

23.00 Only a handful of calcined bones left of carcass.

Dog #8. Bull terrier
Length tip of nose to base of tail 46"
Height 23"
Weight 47 lbs.

Desired to find the effect of a comparatively low EMF passing through the head. For this purpose put two pads of wet cotton wool enclosing wire into the cavities of the ears, bandaging down the external ears over them with a strip fairly tight so as to keep the connection steady. The res: between the electrodes so formed was 6,900ω.

22.55. Direct current passed through head between ears for 4 secs: at 300 volts pressure by switch S. observed current 0.03 amp calculated out $\frac{300}{10,000} = 0.03$ amp

The dog was standing up in a box with his head over the side. While the current was passing there was no struggling or yelping, and beyond the half closing of the eyes and a trembling of the head it would be difficult to see the effect of the current. After removing the current however, the back of the dog arched rigidly as though in a spasm of tetanus, ~~but~~ the animal which it seemed dazed was ~~quite~~ apparently quite conscious. The rigidity continued. He did not struggle violently to escape but looked just as though suffering from strychnine.

Tried next the same voltage only alternated at the high speed (68 per sec)

23.00 300 volt pressure – alternating current through head – for 4 seconds.

A before while the current was on there was little indication of its effect, but on the cessation of the current the effect was ~~most~~ intense. The eyes suffused with blood – and secreted rapidly, the head swayed from side to side, the animal still ~~stood~~ upright but did so with apparent difficulty as the limbs contracted violently. The breathing was spasmodic and laboured, and foam issued at the mouth. The animal had the appearance of mania and may have been unconscious for the first minute (but seemed to slowly regather consciousness) while in the appearance of great pain. Hastened to apply the whole power of the

machine in order to terminate his suffering. Bandaged the legs, as the ear bandages were now discarded. The dog seemed incapable of howling during the whole experiment. At 23.12 attempted at full speed. (68 per sec) the whole power of the machine as heavy collection 1200 volts, and made contact for 4 secs: amperes over 1.2. The animal struggled silently for a few moments and within 15 secs fell back dead. Carcass examined.

Unable to get absolute electrometer to hold its charge. Took it apart and dried it all thoroughly. In resetting it took several more measurements of the elastic force of the spring as follows.

No.	weight.			Diff
	1.680	0.6 gr.	4.255	2.575
	1.688	0.6	4.255	2.567
	1.692	0.6	4.262	2.570
	1.700	0.6	4.260	2.560
				Mean 2.568
	1.695	0.3 gr	3.015	1.320
	1.710	0.3	3.042	1.332
	1.690	0.3	3.021	1.331
				Mean 1.328

Temp 75°F

Brevoort Roberts Cell no 1 first trial

Hours	C.	Coulomb	C²	External Joules	S.R.	Internal Joules	
5	4·04		16·3		0·0175		
10	4·01		16·1		0·0152		
15	3·98		15·8		0·0177		
20	3·92		15·4		0·0222		
25	3·88		15·1		0·0225		
30	3·87		15·0		0·0239		
35	3·87		15·0		0·0240		
40	3·85		14·8		0·0306		
45	3·82		14·6		0·0352		
50	3·80		14·4		0·0402		
55	3·78		14·3		0·0450		
60	3·77		14·2		0·0485		
65	3·78		14·3		0·0479		
70	3·80		14·44		0·0453		
75	3·74		14·0		0·0105		
80	3·41		11·6		0·0300		
85	3·10		9·61		0·0510		
90	2·78		7·73		0·0750		
95	2·48		6·15		0·0940		
100	2·18		4·75		0·1045		
105	1·89		3·57		0·1058		
110	1·62		2·62		0·1067		
115	1·36		1·85		0·1070		
120	1·09		1·18		0·1077		
125	0·94		0·88		0·1030		
130	0·93		0·86		0·1040		
135	0·91		0·82		0·1047		
140	0·90		0·74		0·1041		
145	0·81		0·66		0·1030		
150	0·80		0·64		0·0989		
155	0·78		0·61		0·0953		
160	0·77		0·60		0·0970		
165	0·77		0·59		0·0998		
	85·43	1,538,000	279·16	2,512,000		177,400	2,690,000

Theoretical amp: 519 gm Zn.
Actual loss 1303
Waste 785 or 60·4 %

Percentage useful energy = 93.38 %

Brevoort-Roberts Cell no 2 first trial.

Hours	C.	Coulomb	C²	External Joules	S.R.	Internal Joules	
5	3·51		12·3		0·0715		
10	3·48		12·1		0·0642		
15	3·45		11·9		0·0665		
20	3·42		11·7		0·0724		
25	3·38		11·4		0·0788		
30	3·29		10·8		0·0925		
35	3·21		10·3		0·1130		
40	3·19		10·2		0·0985		
45	3·16		10·0		0·0940		
50	3·16		9·98		0·0897		
55	3·16		9·86		0·0852		
60	3·08		9·49		0·0845		
65	3·00		9·00		0·0875		
70	2·92		8·53		0·0909		
75	2·83		8·01		0·0927		
80	2·67		7·13		0·0887		
85	2·50		6·25		0·0844		
90	2·33		5·43		0·0801		
95	2·16		4·67		0·0759		
100	1·91		3·65		0·0734		
105	1·57		2·46		0·0728		
110	1·36		1·85		0·0745		
115	1·22		1·49		0·0775		
120	1·08		1·17		0·0813		
125	1·06		1·12		0·0750		
130	0·99		·98		0·0540		
135	0·92		·85		0·0536		
140	0·88		·77		0·0587		
145	0·85		·73		0·0615		
150	0·85		·72		0·0578		
155	0·84		·70		0·0556		
160	0·83		·69		0·0625		
165	0·81		·66		0·0705		
	73·07	1,315,000	194·69	1,772,000		293,000	2,065,000

Theoretical amp: 444 gm Zn.
Actual 516
Waste 73 = 14.15 %

% Useful work = 85.79 %

Robert Brewoort cells no 3 1st trial

	B	Bookings	B²	Book Index				
5	3.56		12.7			0.0850		
10	3.52		12.4			0.0688		
15	3.49		12.2			0.0711		
20	3.46		12.0			0.07400		
25	3.44		11.8			0.07762		
30	3.43		11.8			0.0752		
35	3.42		11.7			0.07400		
40	3.37		11.4			0.0761		
45	3.33		11.1			0.0788		
50	3.28		10.8			0.0813		
55	3.22		10.4			0.0839		
60	3.15		9.92			0.0887		
65	3.07		9.06			0.0965		
70	2.90		8.39			0.1047		
75	2.76		7.61			0.1092		
80	2.55		6.50			0.1047		
85	2.34		5.47			0.0947		
90	2.11		4.58			0.0945		
95	1.92		3.76			0.0892		
100	1.71		2.92			0.0867		
105	1.46		2.13			0.0973		
110	1.27		1.61			0.0890		
115	1.12		1.25			0.0910		
120	0.98		0.96			0.0928		
125	0.84		0.88			0.0735		
130	0.89		0.79			0.0751		
135	0.86		0.74			0.0672		
140	0.84		0.71			0.0588		
145	0.81		0.66			0.0555		
150	0.81		0.65			0.0772		
155	0.80		0.64			0.0750		
160	0.79		0.63			0.0697		
165	0.78		0.62			0.0790		
170								
	72.57	1,303,000	194.77	1,749,000		292.500		2,090,600

Theoretical 100 1439 gm.
Actual - 516 -
Waste - 77 = 14.92 %

Percentage useful energy = 86.01 %

Robert Brewoort Cell no 1. 2nd trial

	B	Bookings	B²	Book Index				
5	3.5		12.25	110300		0.100		22060
10	3.48		12.11	109000		0.091		19840
15	3.5		12.25	110300		0.082		18090
20	3.52		12.39	111200		0.074		16460
25	3.55		12.60	113400		0.069		15650
30	3.56		12.67	114000		0.065		14820
35	3.55		12.60	113400		0.066		14960
40	3.52		12.53	112800		0.067		15110
45	3.53		12.46	112200		0.067		15030
50	3.48		12.76	109000		0.069		15040
55	3.43		11.76	105800		0.071		15020
60	3.42		11.69	105200		0.070		14730
65	3.43		11.76	105800		0.067		14186
70	3.44		11.83	106500		0.067		14270
75	3.40		11.56	103800		0.071		14740
80	3.36		11.29	101600		0.074		15040
85	3.28		10.76	96800		0.077		14910
90	3.20		10.24	92100		0.079		12550
95	3.11		9.67	87000		0.081		14090
100	3.00		9.00	81000		0.081		13120
105	2.87		8.24	74200		0.081		12020
110	2.69		7.23	65100		0.081		10550
115	2.51		6.30	56400		0.080		9020
120	2.29		5.24	47200		0.078		7360
125	1.93		3.72	33500		0.075		5020
130	1.76		3.10	27900		0.074		4130
135	1.64		2.69	24200		0.073		3530
140	1.52		2.31	20800		0.072		3000
145	1.49		2.22	20000		0.071		2840
150	1.26		1.59	14300		0.070		2000
155	1.14		1.30	11700		0.069		1610
160	1.01		1.02	9200		0.068		1250
165	.88		.77	6900		0.067		920
170	.72		.52	4700		0.067		630
	91.99	1,656,000	219.78	2,818,000			3785.90	2,893,600

Theoretical 557.59
Actual 607
Waste 49.5
or ~~27.7~~ % total loss.
8.16%

97% total energy.

Percentage useful energy = 87.02 %

Robert Brevoort Cell no 3 2nd trial.

	E.	Coulombs	E.	Get. Joules	Int. Res.	Int. Joules	
5	3.4		11.56	104,100	0.110	25,1000	
10	3.41		11.63	104,700	0.101	211,600	
15	3.45		11.90	107,100	0.093	199,200	
20	3.48		12.11	109,000	0.083	180,900	
25	3.50		12.25	110,300	0.080	176,900	
30	3.52		12.39	111,500	0.078	173,900	
35	3.52		12.39	111,500	0.077	171,700	
40	3.52		12.39	111,500	0.076	169,500	
45	3.51		12.32	110,900	0.076	168,600	
50	3.50		12.25	110,200	0.075	165,300	
55	3.42		11.70	105,300	0.073	153,700	
60	3.42		11.70	105,300	0.074	155,800	
65	3.43		11.76	105,900	0.076	161,000	
70	3.41		11.63	102,700	0.078	163,300	
75	3.39		11.42	102,800	0.083	129,500	
80	3.33		11.09	99,800	0.052	103,800	
85	3.25		10.56	95,000	0.064	121,600	
90	3.17		10.05	90,400	0.079	142,80	
95	3.08		9.49	85,400	0.089	152,000	
100	2.98		8.88	79,900	0.090	141,300	
105	2.86		8.18	73,800	0.090	132,500	
110	2.67		7.13	64,200	0.089	114,300	
115	2.48		6.15	55,400	0.088	97,50	
120	2.23		4.97	44,700	0.087	77,0	
125	1.85		3.42	30,800	0.087	53,60	
130	1.71		2.92	26,300	0.087	45,80	
135	1.60		2.56	23,000	0.087	40,00	
140	1.47		2.16	19,400	0.087	33,80	
145	1.44		1.82	16,400	0.087	28,50	
150	1.23		1.51	13,600	0.087	23,70	
155	1.11		1.23	11,100	0.087	19,30	
160	0.99		0.98	8,800	0.087	15,30	
165	0.87		0.76	6,800	0.087	11,80	
170	0.79		0.62	5,600	0.086	9,60	
	90.98	103,000	273.68	246,500		599,980	2,865,000

Theoretical Z 551 86%

Actual 622

Waste 71 or 11.4% of total loss

Percentage useful Work = 86.04

Mason Wood Cell no 1.

	E.	Coulombs	E.	Get. Joules	Int. Res.	Int. Joules	
5	3.38		11.42	102,800	0.095	19,530	
10	3.14		9.86	88,800	0.107	20,780	
15	2.84		8.06	72,600	0.125	18,150	
20	2.50		6.25	56,300	0.144	16,210	
25	2.10		4.41	39,700	0.173	13,740	
30	1.62		2.62	23,600	0.204	9,630	
35	1.33		1.77	15,900	0.245	7,790	
40	1.06		1.12	10,100	0.287	5,800	
45	0.82		0.67	6,000	0.320	3,840	
50	0.76		0.58	5,200	0.215	2,240	
55	0.72		0.52	4,700	0.100	940	
60	0.70		0.49	4,400	0.167	1,470	
65	0.69		0.48	4,300	0.275	2,360	
70	0.67		0.45	4,100	0.390	3,200	
75	0.65		0.42	3,800	0.427	3,240	
80	0.64		0.41	3,700	0.439	3,240	
85	0.62		0.38	3,400	0.436	2,960	
90	0.61		0.37	3,300	0.433	2,860	
95	0.59		0.35	3,200	0.437	2,800	
100	0.58		0.34	3,100	0.450	2,800	
105	0.58		0.34	3,100	0.468	2,900	
110	0.57		0.32	2,900	0.485	2,900	
115	0.57		0.32	2,900	0.500	2,900	
120	0.56		0.31	2,800	0.500	2,800	
125	0.56		0.31	2,800	0.476	2,660	
130	0.55		0.30	2,700	0.485	2,620	
135	0.55		0.30	2,700	0.499	2,690	
140	0.54		0.29	2,600	0.507	2,640	
145	0.53		0.28	2,500	0.525	2,620	
150	0.52		0.27	2,400	0.540	2,590	
155	0.52		0.27	2,400	0.554	2,490	
160	0.51		0.26	2,300	0.566	2,720	
165	0.50		0.25	2,200	0.578	2,660	
170	0.50		0.25	2,200	0.561	2,480	
	35.59	400,400	58.01	49,500		181,150	576,500

Theoretical Z 203.5

Actual 526. Waste 322.5 or 62.73% total loss. Percentage useful Work = 71.23

Mason - Wood cell no 2.

Hours	C.	Coulomb	C²	Ext. foots	Int. H.	Int. foots	
.5	3.40		11.56	104,000	0.072	14,980	
10	3.26		10.62	95,600	0.089	17,020	
15	3.12		9.73	87,600	0.108	18,570	
20	3.00		9.00	81,000	0.122	17,760	
25	2.98		8.88	79,900	0.127	22,280	
30	2.85		8.12	73,100	0.150	19,000	
35	2.42		5.85	52,700	0.147	15,490	
40	1.95		3.80	34,200	0.167	11,420	
45	1.48		2.19	19,700	0.180	7,090	
50	1.18		1.39	12,500	0.145	3,910	
55	0.92		0.85	7,700	0.110	1,890	
60	0.85		0.72	6,500	0.160	2,080	
65	0.80		0.64	5,800	0.230	2,700	
70	0.74		0.55	5,000	0.313	3,130	
75	0.71		0.50	4,500	0.324	2,920	
80	0.69		0.48	4,300	0.332	2,850	
85	0.67		0.45	4,100	0.336	2,760	
90	0.65		0.42	3,800	0.343	2,600	
95	0.63		0.39	3,500	0.348	2,440	
100	0.61		0.37	3,300	0.360	2,370	
105	0.60		0.36	3,200	0.370	2,360	
110	0.60		0.35	3,200	0.380	2,430	
115	0.59		0.35	3,200	0.392	2,500	
120	0.58		0.34	3,100	0.395	2,440	
125	0.58		0.34	3,100	0.384	2,380	
130	0.57		0.32	2,900	0.383	2,220	
135	0.57		0.32	2,900	0.385	2,230	
140	0.55		0.31	2,800	0.389	2,180	
145	0.56		0.31	2,800	0.392	2,200	
150	0.55		0.30	2,700	0.395	2,130	
155	0.54		0.29	2,600	0.397	2,060	
160	0.54		0.29	2,600	0.400	2,080	
165	0.54		0.29	2,600	0.403	2,090	
170	0.53		0.28	2,600	0.409	2,120	
	40.82	734,500	80.96	730,000		52,480	932,500

Theoretical In heat watts 247.4 gro 526 = 276.6 = 52.79%

Percentage useful Work = 71.28%

Mason - Wood Cell no 2.

Hours	C.	Coulomb	C²	Ext. foots	Int. H.	Int. foots	
5	3.27		10.69	96,200	0.132	25,200	
10	3.26		10.50	94,500	0.123	23,200	
15	3.18		10.11	91,000	0.116	21,100	
20	3.12		9.73	87,600	0.108	18,900	
25	2.98		8.88	79,900	0.117	18,700	
30	2.79		7.78	70,000	0.130	18,200	
35	2.35		5.52	49,700	0.218	21,400	
40	1.87		3.50	31,500	0.300	18,900	
45	1.38		1.90	17,100	0.375	12,800	
50	1.10		1.21	10,900	0.320	7,000	
55	0.86		0.74	6,700	0.240	2,200	
60	0.77		0.59	5,300	0.270	1,900	
65	0.72		0.52	4,700	0.323	3,100	
70	0.68		0.46	4,100	0.410	3,400	
75	0.65		0.42	3,800	0.424	3,200	
80	0.63		0.40	3,600	0.433	3,000	
85	0.61		0.37	3,300	0.435	2,900	
90	0.60		0.36	3,200	0.437	2,800	
95	0.59		0.35	3,200	0.442	2,800	
100	0.58		0.34	3,100	0.456	2,800	
105	0.56		0.31	2,800	0.471	2,600	
110	0.56		0.31	2,800	0.487	2,700	
115	0.56		0.31	2,800	0.500	2,800	
120	0.56		0.31	2,800	0.517	2,900	
125	0.56		0.31	2,800	0.525	2,900	
130	0.56		0.31	2,800	0.527	2,900	
135	0.55		0.30	2,700	0.544	2,900	
140	0.54		0.29	2,600	0.561	2,900	
145	0.53		0.28	2,500	0.580	2,900	
150	0.52		0.27	2,400	0.599	2,900	
155	0.52		0.27	2,400	0.612	2,900	
160	0.51		0.26	2,300	0.622	2,900	
165	0.50		0.25	2,300	0.630	2,900	
170	0.50		0.25	2,300	0.624	2,900	
	39.50	711,000	78.40	705,700		237,900	963,400

Theoretical 239 kgm
Actual 521
waste 281.6 = 54.01%

Percentage useful Work = 73.26.

Notebook, N-88-06-10

This notebook, which covers the period June-August 1888, is a continuation of N-88-06-06. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. Included are notes, drawings, tables, and calculations regarding batteries, non-magnetic watches, photometers, condensers, electric meters, and electrocution experiments. Among the experimenters whose work appears in this book are F. P. Bergh, E. C. Boynton, Alex W. Brigham, and Johannes H. Cuntz. The front cover is labeled "Record Book No 4." The back cover is labeled "509." The spine is labeled "53." Attached to the inside back cover is an index. The book contains 89 numbered pages. Some pages were removed before the book was paginated.

The index has been filmed first. Oversize graphs, formerly pasted onto pages 44, 50, 51, 60, 62, and 89, have been filmed at the end of the book at a reduction ratio of 18:1.

xE172

N-88-06-10

Record Book
of
Observations, Calculations, and
Data
Edison Laboratory
Galvanometer Building

Resumé of particulars of Primary Battery Test previous to making Report upon them.

---

3 — 2-cup Brewsort-Robert Zinc Carbon cells were received at the laboratory on the 10th June. 88. Their price @ per invoice was $12.50 each and the solution supplied with them, apparently a bicromate of potash solution, was charged at 20 ct per gall. (10% discount was allowed on these prices)

These cells were stated to give a current of 4 ampires for several hours or 6 6 8 ampires for a few mins. at a time. Mr Meadowcroft said that a capacity of 500 ampire-hours was claimed for them, vide his letter of the 10th May.

The cells were set up according to directions on the 14th June with 1½ gallons of solution in the outer cell and water with salt added to it was poured into the porous cells round the zincs. The total amount of solution in each complete cell was thus about 10,000 c.c.

The zinc plates are about 35.6 × 15.1 × 0.18 are two to each complete cell and weigh about 1815 grammes each single cell exposing about 2150 sq. cms. of ~~plate~~ surface. and of this some 1850 is active in solution. The carbon plates are 3 in number weigh about 900 grammes, dimension 40 × 17.4 × 0.33. The surface of each plate is about 1400 sq. cms. and the active surface of the three together is about 1700 sq. cms excluding the two outside surfaces.

The three cells were set to work at 8.45 on the 15th June through a coil of stranded platinoid wire 4 wires each 0.084 cms diam. and offering together 0.5 ω.

The EMF commenced at 2.1 volts
" " int. res " " 0.06 ω
and " current " " 3.8 amps.

No change was made in the conditions during the test beyond adding water to the zinc cells as the liquid fell in them.

The test lasted for 165 hours at the end of that time the
EMF was about 0.45 volt
Int. Res. " " 0.06 ω
Current " " 0.6 amp

The energy developed by no 1 cell was 2,690,000 Joules
of which % = 2,512,000.
was externally evolved.
The quantity of electricity delivered 1,538,000 Coulombs
The zinc theoretically consumed to supply this
observed current was 518 grammes
The actual loss of zinc was 1303
representing a waste of % = 785

The energy developed by no 2 cell was 2,066,000 J.
of which % = 1,772,000
was externally evolved.
The quantity delivered was 1,315,000 C.
for which the zinc consumed should be 443 grs.
and actually was 516.
representing a waste of % = 73

The energy developed by no 3 cell was 2,091,000 J
of which % = 1,798,000.
was externally evolved
The quantity delivered was 1,303,000 C
for which the zinc consumed should be 439 grs.
and was actually 516
representing a waste of % = 74.

This is shown in the following scheme.

Cell No.	Coulombs delivered	Joules Energy Externally	Joules Internally	Total Joules	Zinc Theory Grms	Thousandth Part Expected	Actual Loss of Zinc	% Waste
1	1,538,000	2,512,000	178,000	2,690,000	432	518	1303	142
2	1,315,000	1,772,000	294,000	2,066,000	351	443	516	142
3	1,303,000	1,798,000	293,000	2,091,000	440	439	516	149
Mean	1,385,000	2,027,000	255,000	2,282,000				

The mean delivery of useful energy was thus 2,027,000 Joules or 1,494,000 ft. lbs:
the maximum 2,512,000 - 1,852,000 - -
- minimum. 1,772,000 - 1,306,000 - -

The rate of doing external work was at the outset (7.25 m) 8.3 Watts for cell no 1 at 0.011 Hot plate alle 6 Hot 90
6.15 - - - 2 0.008 121 -
6.35 - - - 3 0.0085 1175 -

The full powers of the cells may be said to have been as follows.
No 1. 7.0 Watts or over up to the 75th hour
- 2 5.0 - - - - - 50th -
- 3 5.0 - - - - - 60th -

The mean current for the 1st 75 hours of cell no 1 was 3.86 amperes a capacity of 290 amp.
- - - 2 - 2.59 - - in all - - - 427 - -
The mean current of #2 was 2.21 - - - - - 365 - -
- - - - #3 - 2.19 - - - - - 362 - -

The cells were taken down and put out of use until the 9th July 1888. The zinc plates were then amalgamated and weighed. There was found to be solution enough for ~~for~~ only two cells as although the third was run on half solution, it is left out of consideration. The ~~to~~ cells were set to work at 15.30 through 0.5 m as before

The trial lasted for 170 hours with the following results:—

Cell No.	Gallons delivered	Energy delivered				Zinc Consumed			Power at cell terminals	Volts from Curve	Volts per cell
		Ent:	Int.	Total	%	Theoretical	Actual	% Theoret.			
1	1,656,000	2,518,000	376,000	2,894,000	87	557.5	607	89%	6.15	5.4 volts	12.1
3	1,637,500	2,465,000	400,000	2,865,000	86	557.	622	12.9	5.78	5.8 volts	12.9
Mean	1,647,000	2,492,000	388,000	2,880,000	86						

The mean current for the ~~whole~~ period was (#1) 2.79 amperes a mean copy of 460 amp. hours.
(#2) 2.68 " " " " 455 "

The improved performance of the cells on the second occasion was supposed to be due to the amalgamation of the zinc plates.

About 120 cells go to a H.P. at 4 amperes per cell on this outlet.
For steady work 150 would have to be allowed. The duration of the cells might be perhaps 120 hours continuously. This would mean $\frac{150 \times 1\frac{1}{2}}{120}$ or 1.9 gallons of solution per hour also

$$\frac{3.5 \times 150 \times 1.1}{370} \text{ lbs. of Zn per H.P.}$$
$$= 1.56 \text{ lbs}$$

1.9 gallons of sol: @ 20 cts =	0.38
1.56 lbs of zinc - @ 7 cts	.11
Cost of material per H.P. hour	0.49

Three Mason-Wood cells reached the laboratory on the 2nd July but as part of them were found broken it was not till the 8th July that the materials were complete.

These are zinc-carbon two-fluid cells the outer jar being earthenware, and the two zincs being in the outer cell, one on each side of the porous pots with the carbons double in it.

The cells were made up according to the instructions received – namely sulphuric acid + water 5% in the outer cells and the special solution apparently a bicarbonate of potash solution poured into the porous pots to the extent of about 2 quarts.

The zinc plates were amalgamated. Their dimensions being 33 X 15·4 X 0·5 exposing a surface of about 1000 sq. cms. each of which only about 600 sq. cms. are exposed to the liquid, or about 1200 in all. The outer cells have sloping sides but the mean dimensions are 18 wide x 25 long X 31 deep, inside measurement, and they hold about 10,000 c.c. of solution under ordinary circumstances.

The weight of the zincs is about 5lb or 2300 grammes each. The carbons are double each has a surface on one face of 15×31 = 465 sq. cms. of which some 360 are exposed in liquid making an active surface of some 750 sq. cms.

The price of the cells is @ per invoice $11.20 each. The solution is 75 ct a gallon, and half a gallon is used as a charge.

The cells were set to work with the Brevoort Robert at 15.30 on 0.5 platinoid strand of the filey. Their

EMF at starting was 2.09 volts
I.R 0.07 ω
Current 3.7 amp

The test lasted for 170 hours. At the end of which time the EMF was 0.5 volts
I.R. 0.5 ω
Current 0.5 amperes.

The plates were then weighed and the output found to be @ follows:—

Cell	Quantity delivered	Energy delivered				Time consumed			
	Coulomb	Externally	Internally	Total	% output	Theoretic	Actual	Waste	Cost
#1	604,600	495,300	181,200	676,500		203.5	514.6	311.1	61.4%
#2	734,800	730,000	202,500	932,500		247.4	521.6	274.2	
#3	711,000	705,700	257,700	963,400		239.4	521.6	281.6	
Mean	683,000	642,000	213,000	857,000					
of tests	723,000	718,000	230,000	948,000					

It should be stated that the carbon of no 1 cell was a double one with a consequently double head and this was set in position touching both zincs for two hours before it was noticed. This may have short-circuited that cell for two hours and if so it will account for the reduced output and excessive waste of zinc. Our figures therefore are based on nos. 2 + 3.

For the 1st 5 hours

No 2 had an output of 5.8 Watts or 129 to the HP.
3 . . . . 5.4 . . 138 . . .

The mean current from No 2 was 1.24 amp.
a capacity of 210 ampere hours.
The mean current from No 3 was 1.20 amps
a capacity of 204 ampere hours.

At fifty hours the output was 0.7 Watts from No 1
0.6 Watts . . 2
Meaning more than 1000 to the HP

To supply a H.P. for 24 hours.
after the 25 hour both cells gave 2.44 Watts or 168 HP
so that 150 cells would be required.
The mean current during that hour would be 3.25 amp
The consumption of zinc would be $\frac{3.25 \times 150 \times 2}{370}$ = 0.17
= 2.44 lbs. per HP. hour @ 7 cts = 1.12
Solution say half exhausted = $\frac{1}{2} \times 2.44 \times \frac{150}{2.5} \times 0.75$
Cost of Material per H.P. hour. 1.29
neglecting H2SO4

Made up a transformer as follows –

Upon a coil of iron wire (no 26) 0·018" about 20 cm meni diam: 20 oz of no 23 wire silk covered was wound and this layer after being taped with india rubber was covered with 12 oz of no 30 silk covered wire

The Res. of the copper wire was 10·5 ω
that - - - fine - - 106 ω.

No 23 wire ·025" has 60·5 feet per ω = 635 feet.
- 30 - ·012" - 114 - - - 1184 -

Subsequently increased the 2nd wire by 5 oz: and to a resistance of 151·2 ω @ 85°
no 30 BWG ·0·012" = 2100 feet.

alteration of Rate

	122 20
1.0	0 00
1.0	0 5
.25	0 7.5
.75	3 25
1.5	8 5
.5	1.0
1.75	5 7.5
2.5	8 25
2.5	1.0
8.5	2.0
6.0	2.0
4.0	1.0
6.25	1.5
1.0	0 25
9.25	2.75
18.0	3.0
4.00	0.25
0.5	1.75
6.25	7.0
1.0	2.8
2.25	0.75
3.5	2.25
.75	2.5
2.0	3.25
3.75	2.5
1.50	2.0
.25	186 2.5
1.75	2.0
1.0	58
.75	
1.0	
10.0	
8.0	
6.5	
3.0	
122 6 0	

67 | 162 / 184 / 260 | 12

58 186 25 321
1225
65

Watch #1 Paillard $51.872 $ 67.50 .. 3.21

Date	Hour	Error	Rate	Temp	Rate for 24 hrs	Date	Hour	Error	Rate	Temp	Rate for 24 hrs
28.6.	13.20	-17		66°		3.8.88	8.15	+80	+8½	80°	
29.6	8.40	-20	-3	66°	-3¾	4.8.88	8.15	+88½	+8½	80°	
30.6	8.40	-22¾	-2¾	65°		5.8.88	9.30	+88½	0	80°	
1.7	10.00	-24½	-1¾	67°		6.8.88	9.15	+94	+5½	80°	+5¾
2.7	11.00	-26	-1½	69°		7.8.88	8.28	+103	+9	80°	
3.7	8.20	-28	-2	70°	-2¼	8.8.88	8.20	+103½	+½	76°	
4.7	8.30	-28¾	-¾	70°		9.8.88	8.15	+105	+1½	75°	
5.7	8.40	-29	-¼	76°		10.8.88	9.15	-22½	+127½	78°	
6.7	8.25	-27½	+1½	76°		11.8.88	8.10	+13	+135½	76°	
7.7	8.30	-33½	-6	78°		12.8.88	10.00	+21½	+8½	80°	+7¼
8.7	9.50	-37	-3½	95°		13.8.88	8.15	+28	+6½	78°	+7
9.7	8.15	-32	+5	100°		14.8.88	8.20	+34	+6	80°	
10.7	8.10	-33	-1	105°		15.8.88	8.20	+42	+8	80°	
11.7	8.50	-39	+3	76°		16.8.88	8.20	+52	+10	80°	
12.7	8.25	-33½	-3½	49°		17.8.88	8.25	+63	+11	82°	
13.7	9.05	-35½	-2½	49°			8.35	+82	+19		~~+15~~
14.7	8.15	-47	-11½	49°		18.8.88	8.20	+92	+10	80°	+10½
15.7	10.00	-40	+7	100°	+6½	19.8.88	10.20	+103	+11	82°	+10½
16.7	8.20	-34½	+5½	100°	+10¼	20.8.88	8.20	+110	+7	82°	+7¾
17.7	8.20	-21	+9½	100°			12.05	-172	-282		~~+14½~~
18.7	8.15	-12	+9	100°		21.8.88	8.20	-163	+9	80°	+10¾
19.7	8.10	-2	+10	100°			8.25	-152	+9	78°	
20.7	8.20	+10½	+12½	100°		22.8.88	11.35	-152	+3	76°	
21.7	8.25	+10	+0½	78°			8.20	-142	+10	75°	
22.7	10.05	+27	+8	78°	+8½	23.8.88	10.15	-142	+4	76°	+4½
23.7	8.25	+33	+6	78°	+6½		10.25	-140	+0		+8¾
24.7	8.20	+38½	+5½	40°		24.8.88	8.16	-140	+3	74°	+2½
25.7	8.20	+38	+2½	40°		25.8.88	9.55	+79½	+5½	74°	+5
26.7	8.20	+40½	+½	35°		26.8.	8.18	+86	+6½	74°	+7
27.7	8.20	+41½	+1½	35°		27.8.					
28.7	9.40	+43	+1	35°		28.8	8.20				
29.7	10.00	+44½	+2	38°							
30.7	8.20	+46	+1½	100°							
1.3.7	8.25	+57	+11	100°							
2.1.8	8.20	+60	+3	80°							
2.8	8.20	+71½	+11½	100°							
3.8	8.15	+80	+8½	80°							

1.5.
1.0
1.0
1.0
1.5
1.5
3.5
2.5
2.75

Watch no 2. Pallmark # 56 608 $22.50.

Date	Time	Error by Clock	Rate	Temp	Bat.	Calc. Error 24 hrs	Date	Time	Error	Rate	Temp	Bat.	Calc. Error 24 hrs
28.6.	13.25	+34½					3.8.88	8.15	-202	-8	80°	D.U	
29.6	8.40	+28	-7	66°	D.U.	-8¾	4.8.88	8.15	-210	-5	80°		
30.6	8.40	+21	-7	66°	D.U.		5.8.88	8.30	-215	-5	80°	D.U	-4¾
1.7	10.00	+12½	-8½	69	"	-8	6.8.88	8.15	-219	-4	80°		
2.7	11.00	+4½	-8¼	69		-8	7.8.88	8.25	-224½	-7½	80°	D.U.	
3.7	8.20	± 2	-6½	70		-7	8.8.88	8.20	-235	-8¾	78°	D.D.	
4.7	8.30	-7½	-5½	74			9.8.88	8.15	-243½	-7½	78°	D.D.	
5.7	8.40	-11½	-4	76	D.U		10.8.88	8.15	-252	-8½	78°	D.U.	
6.7	8.25	-19	-7½	78	D.U		11.8.88	8.10	-265	-13	76°	D.U.	
7.7	8.30	-24	-5	78	D.D								
8.7	9.50	-32½	-8½	95	D.U.	-7¾	12.8.88	10.00	-275	-10	80°	D.U	-9¾
9.7	8.15	-44½	-11¾	100	D.U.	-12½	13.8.88	8.15	-284	-9	78°	D.U	-9¾
10.7	9.8	-56	-12	108	D.D.	-11½	14.8.88	8.20	-292	-8	80°	D.U	
11.7	8.50	-65	-9¾	74	D.U		15.8.88	8.20	-302¾	-10¼	80°		
12.7	8.25	-68	-1¾	69	D.U		16.8.88	8.20	-314	-11¼	80°		
13.7	8.05	-67¾	+¼	69	D.U		17.8.88	8.25	-322	-11	82°		
14.7	8.15	-69	-1¼	69	D.D		18.8.88	8.35	-332¾	-10¾			-6.88¾
15.7	10.00	-82	-13	100	D.U.	-12	19.8.88	8.20	-344½	-12	80°		-11¾
16.7	8.20	-94	-12	100		-13	19.8	10.20	-357	-12½	80°		
17.7	8.20	-103	-9	100			20.8	8.20	-366	-9	82°		
18.7	8.15	-114½	-11½	100			21.8	12.05	-368¾	-2¾			-18.88
19.7	8.10	-125¾	-11¼	100				8.20	-375	-6¼	80°		-7½
20.7	8.20	-138¾	-13	110				19.25	-386	-7	78°		
21.7	8.25	-144¾	8	78	D.U		22.8	18.35	-386½	¼	78°		
22.7	10.05	-153¾	-7	78		-8¾	23.8	5.20	-390	-7½	78°		-8¾
23.7	8.25	-160	-6½	76°			24.8	10.15	-399	-9	76°		
24.7	8.20	-159¾	+¾	35°	D.U			10.45	-400	-2½			-8.5
25.7	8.20	-158	+1¾	35°	D.U		25.8	8.16	-401½	-1½	74°	D.U.	-16½
26.7	8.20	-157	-1	35°	D.U		26.8	19.00	-403½	-16½	74°		-16½
27.7	8.20	-161	-2	35°			27.8	8.20	-405	-1½	74°		-20
28.7	8.20	-161	0	35°									
29.7	10.00	-162	-1	35°									
30.7	8.20	-164	-2	35°									
31.7	8.25	-177	-13	100°									
1.8	8.20	-180½	-3½	40°									
2.8	8.20	-193	-12½	100°									

Watch No 3 Paillard Non Mag. 6 ⌀ 350.438 $ 7.50 (12)

Date	Hour	Error by Clock	Rate	Temp F	Cond	Rate for 24 hrs
28.6	13.25	+77	-8	66°	D.U.	-3½
29.6	8.40	+74				
30.6	8.40	+69	-5	66°	"	
1.7	10.00	+53	-16	69°	"	-15½
2.7	11.00	+38	-15	69°	"	-14½
3.7	8.20	+23	-15	70°	"	-16½
4.7	8.30	+9	-14	74°	"	
5.7	8.40	-26	-35	76°	D.U.	
6.7	8.25	-42½	-16½	76°	D.U.	
7.7	8.30	-57½	-15	76°	D.D.	
8.7	9.50	-91	-33½	95°	D.U.	-34½
9.7	8.15	-98½	-2½	100°	D.U.	
10.7	9.45	-105½	-7	108°	D.D.	-95½
11.7	8.50	-116	-18½	74°	D.U.	
12.7	8.25	-110½	+4½	89°	D.U.	
13.7	8.05	-98½	+21	89°	D.U.	
14.7	8.15	-76	+22½	89°	D.U.	
15.7	10.00	-113½	-37½	100°	D.U.	-35½
16.7	8.20	-167	-53½	100°	"	-57½
17.7	8.20	-202	-35	100°	"	
18.7	8.15	-238½	-36½	100°	"	
19.7	8.10	-280½	-41½	100°	"	
20.7	8.20	-334	-53½	100°	"	
21.7	8.25	-362½	-3½	79°	D.U.	
22.7	10.05	-368½	-6	78°	"	-5½
23.7	8.25	-353½	+7½	78°	"	-7½
24.7	8.20	-328½	+27	85°	D.U.	
25.7	8.20	-301	+26½	88°	D.U.	
26.7	8.20	-290½	+13½	85°	"	
27.7	8.20	-279	+16½	85°	"	
28.7	8.40	-250	+29	85°	"	
29.7	10.00	-227½	+22½	85°	"	-21½
30.7	8.20	-196½	+32½	85°	"	-19½
☾ 31.7	8.25	-214	-17½	100°	"	
☾ 1.8	8.20	-187½	+26½	100°	"	
☾ 2.8	8.20	-158	+29½	100°	"	

Date	Hour	Error	Rate	Temp F	Cond	Rate for 24 hrs
3.8	8.15	-150	+8	80°	D.U.	
4.8	8.15	-98	+52	80°	"	
5.8	9.30	-87	+11	80°	D.U.	+10½
6.8	8.15	-53	+34½	80°	"	
7.8	8.25	-19	+34	80°	D.U.	+33½
8.8	8.20	-27	-8	76°	D.D.	
9.8	8.15	-31½	-4½	78°	D.D.	
10.8	8.15	+02	+33½	78°	D.D.	
11.8	8.10	-61½	-63½	76°	D.U.	
12.8	10.00	-31	+30½	80°	D.U.	+28
13.8	8.15	+34	+65	78°	D.U.	+70
14.8	8.20	+82	+48	80°	D.U.	
15.8	8.20	+120	+38	80°	"	
16.8	8.20	+162	+42	80°	"	
17.8	8.25	+197½	+35½	82°	"	
	9.35	+193½	-4		"	
18.8	8.20	-163	+26½	84°	"	+21½
19.8	10.20	-136	+27	84°	"	+26
20.8	10.20	-116½	+19½	82°	"	
	12.05	-483	-366		"	
21.8	8.20	-466	+17	80°	"	+20½
22.8	8.25	-425	+41	78°	"	
	11.35	-448	-23	78°	"	
23.8	8.20	-439½	+8½	78°	"	+9½
	10.15	-371	+68½	76°	"	+63½
24.8	10.45	-423	-52½		"	
25.8	8.15	-367	+56	76°	D.U.	+63
26.8	10.00	-352	+15	76°	"	+14½
27.8	8.20	-293	+61	76°	"	+49

Watch No 14 Waltham 3,457,605 $21.00

(13)

Date	Time	Error Stop Watch	Rate	Temp	Cond	Rate for 24 hrs.
28.6	13.25	-19	stopped	66°	D.U.	—
29.6	8.40	+24½	stopped	66°	"	—
30.6	8.40	+9	stopped	69°	"	—
Feb. 1.7	10.00	-51	stopped	69°	"	—
2.7	11.00	-17½	+33½	69°	"	+32
3.7	8.20	+9½	+27½	70°	"	+30½
4.7	8.30	+42	+32½	72°	"	+32½
5.7	8.40	+49½	+7½	76°	P.U.	+7½
Mar. 6.7	8.25	+85	+35½	78°	D.U.	+35½
7.7	8.30	+121½	+36½	78°	D.U.	+36½
8.7	9.50	+170½	+49½	95°	P.U.	+49½
9.7	8.15	+219½	+49½	100°	D.U.	+49½
10.7	9.08	+266½	+46½	102°	D.U.	+46½
11.7	8.50	+263	+16	72°	P.U.	+16
12.7	8.25	+309½	+46½	49°	P.U.	+46½
Apr. 13.7	8.05	+347½	+38	49°	D.U.	+38
14.7	8.15	+392½	+45½	49°	D.U.	+45½
15.7	10.00	+553½	+33½	100°	D.U.	+33½
16.7	8.20	+582	+28½	100°	"	+28½
17.7	8.20	+619½	+37½	100°	"	+37½
May 18.7	8.15	+638	+18½	100°	"	+18½
19.7	8.10	+693½	+55½	110°	"	+55½
20.7	8.20	+678	+20½	110°	"	+20½
21.7	8.25	-224	stopped	78°	D.U.	—
22.7	10.05	+165	stopped	78°	D.U.	—
23.7	8.25	+125½	+26½	78°	"	+26½
24.7	8.20	+55	+12½	125°	D.U.	+12½
25.7	8.25	+01	stopped	38°	D.U.	—
26.7	8.20	+21	+20	45°	"	+20
27.7	8.20	+37½	+16½	35°	"	+16½
June 28.7	8.40	+53½	+15½	35°	"	+15½
29.7	10.00	+69	+15½	35°	"	+15½
30.7	8.20	+85½	+15½	35°	"	+15½
H 31.7	8.25	+110	+23½	100°	"	+24½
G. 1.8	8.20	+119	+9	110°	"	+9
H 2.8	8.20	+115	stopped	100°	"	—

Date	Hour	Error	Rate	Temp	Cond	Rate for 24 hrs.
3.8	8.15	+235½	stopped	80°	D.U.	—
4.8	8.15	-23	stopped	80°	"	—
5.8	9.30	+195½	+219	80°	P.U.	+207½
6.8	8.15	+240½	+45	80°	"	+47½
7.8	8.25	+261½	+21½	80°	D.U.	+21½
8.8	8.20	+291	+29½	76°	D.U.	+29½
9.8	8.15	+320½	+29½	78°	D.U.	+29½
10.8	8.15	+500	+178½	78°	P.U.	+178½
11.8	8.10	+382	-118	76°	P.U.	-118
12.8	10.00	+406	+24	80°	D.U.	+22½
13.8	8.15	+431	+25	78°	D.U.	+27
14.8	8.20	+453½	+22½	80°	D.U.	+21½
15.8	8.20	+477½	+25	80°	"	+25
16.8	8.20	+498½	+20½	80°	"	+20½
17.8	8.25	+521	+22½	82°	"	+22½
	9.35	+550	+29	"	"	+29
18.8	8.20	+571½	+21½	82°	"	+46½
19.8	10.20	+593½	stopped	82°	"	—
20.8	8.20	+614	+37½	82°	"	+41
	12.05	-277½	-391½	"	"	—
21.8	8.20	-311	-34½	80°	"	-48
22.8	8.25	-360	-46	78°	"	-46
	11.35	-423	-63	78°	"	—
23.8	8.20	-442½	-25½	76°	"	-29
	10.15	-462	-16	76°	"	-14½
24.8	10.45	-522	-58	"	"	—
25.8	8.15	-548	-26	76°	D.U.	-29
26.8	10.00	-570½	-22½	76°	"	-39½
27.8	8.20	-617	-46½	76°	"	-27½
28.8	8.20	-641	-24	76°	"	

Watch No. 5. Waltham 3,5314,801L $18.00 (112)

Date	Time	Comp. 24 Clock	Rate	Temp	Beat	Date	Hour	Comp.	Rate	Temp	Beat	Comp. 24 Clock
28.6	13.25	-12.5	stopped	66°	D.U.	3.8	9.15	-12.62	-39½	80°	D.U.	-39½
29.6	8.40	+12½				4.8	9.15	-13.02	-40	80°	..	-40½
30.6	8.40	-22½	-39½	66°	- 39	5.8	9.20	-13.28	-26	80°	P.U.	-24½
1.7	10.00	-65½	-44	69°	- 39	6.8	8.15	-13.55	-30	80°	..	-31¼
2.7	11.00	-99	-33½	69°	- 33	7.8	8.25	-13.92	-37	80°	D.U.	-37
3.7	8.20	-131	-32	70°	- 32	8.8	8.20	-14.35	-42	76°	D.U.	-40
4.7	8.30	-171½	-40½	74°	- 40	9.8	8.15	-14.79½	-44½	78°	D.U.	-40½
5.7	8.40	-203½	-32	75°	P.U. 32	10.8	8.15	-14.91½	-12½	78°	P.U.	-42½
6.7	8.25	-238½	-35½	78°	D.U. 35	11.8	8.10	-15.33½	-41½	75°	P.U.	-42½
7.7	8.30	-276	-37½	78°	D.U. 37	12.8	10.00	-15.71	-42½	80°	D.U.	-39½
8.7	9.50	-305	-29	95°	P.U. 29	13.8	8.15	-15.86½	-36½	78°	D.U.	-38
9.7	8.15	-340	-35	100°	D.U. 35	14.8	8.20	-16.05½	-42½	80°	D.U.	-42½
10.7	9.05	-381	-41	108°	D.U. 39	15.8	8.20	-16.51	-42½	80°	..	-42½
11.7	8.50	-407½	-26½	74°	D.U. 27	16.8	8.20	-17.05	-54	80°	..	-57
12.7	8.25	-427½	-20	69°	P.U. 20	17.8	8.25	-17.72	-67	82°	..	-64
13.7	8.05	-459	-31½	69°	D.U. 32		9.35	-20.22	stopped			
14.7	8.15	-500½	-41½	69°	D.U. 39	18.8	8.20	-20.58	-36½	84°	..	-54½
15.7	10.00	-524	-40½	100°	D.U. 37	19.8	10.20	-20.87	-57½	84°	..	-55¼
16.7	8.20	-577	-36	100°	- 36	20.8	8.20	-21.41	-54	82°	..	-57½
17.7	8.20	-602½	-32½	100°	- 32		12.05	-28.82	-31½		..	
18.7	8.15	-650½	-41½	100°	- 41	21.8	8.20	-30.11	-129	80°	..	-153
19.7	8.10	-689	-38½	100°	- 38	22.8	8.25	-32.25	-115½	78°	..	-115½
20.7	8.20	-727½	-38½	110°	- 38		11.35	-33.93	-62½	78°	..	
21.7	8.25	-765½	-39½	78°	D.U. 39	23.8	8.20	-35.30	-93½	78°	..	-105
22.7	10.05	-804½	-35	78°	- 38	24.8	10.15	-36.02	-124	76°	..	-114¼
23.7	8.25	-836	-32½	78°	- 37		10.45	-36.67	-63	76°	..	
24.7	8.20	-872½	-38½	85°	D.U. 37	25.8	9.15	-36.91½	-152½	74°	D.U.	-102½
25.7	8.20	-913	-38½	85°	D.U. 38	26.8	10.00	-37.78½	-153½	74°	..	-143½
26.7	8.20	-949½	-36½	85°	- 36	27.8	8.20	-39.03	-126½	74°	..	-137½
27.7	8.20	-987	-37½	85°	- 37	28.8	8.20	-40.53	-151	74°	..	
28.7	6.40	-1020½	-41½	85°	- 41							
29.7	10.00	-1069	-39½	85°	- 39							
30.7	8.20	-1105½	-38½	85°	- 38							
N. 31.7	8.25	-1142	-34	100°	- 34							
N. 1.8	9.20	-1176	-34½	80°	- 34							
N. 2.8	8.20	-1222½	-43½	100°	- 43							

Watch No. 6. Waltham # 3,511,918 $. 5.00

Date	Time	Error Watch	Rate	Temp	Lie	Rate for 24 hrs
28.6	13.25	-44½	stopped	66°	D.U.	—
29.6	8.40	+46	stopped	66°	"	—
30.6	8.40	+13½	+23	69°	-	+16¾
1.7	10.00	+5½	stopped	69°	-	—
2.7	11.00	-22	stopped	70°	-	—
3.7	8.20	[illegible]	+10½	74°	-	+18½
4.7	8.30	+38½	-18¾	76°	P.U.	-18¾
5.7	8.40	-71½	-9½	76°	D.U.	-9½
6.7	8.25	-80½	-2½	76°	D.U.	-2½
7.7	8.30	-101	-23¾	90°	P.U.	-33¾
8.7	9.50	-144¾	-27½	100°	D.U.	-27½
9.7	8.15	-172	-34	100°	D.U.	-34
10.7	9.05	-206	-32¾	74°	P.U.	-33¾
11.7	8.50	-238¾	-25¾	74°	P.U.	-25¾
12.7	8.25	-264	-15¾	74°	P.U.	-15¾
13.7	8.05	-279¾	-14¾	74°	D.U.	-19¾
14.7	8.15	-294½	-32½	100°	D.U.	-30¾
15.7	10.00	-327	-24	100°	-	-24¾
16.7	8.20	-351	-17	100°	-	-17
17.7	8.20	-368	-19½	100°	-	-19½
18.7	8.15	-387½	-19½	100°	-	-19½
19.7	8.10	-407	-21½	100°	-	-21½
20.7	8.20	-428½	-17½	78°	D.U.	-17½
21.7	8.25	-449	-13¾	78°	-	-13¾
22.7	10.05	-462¾	-12¾	75°	-	-13¾
23.7	8.25	-475	-12	45°	D.U.	-12
24.7	8.20	-487	-10½	57°	-	-10½
25.7	8.20	-497½	-12½	45°	-	-12½
26.7	8.20	-510	-16	35°	-	-16
27.7	8.20	-526	-12	35°	-	-12
28.7	8.40	-538	-22	35°	-	-20¾
29.7	10.00	-560	-21	38°	-	-22½
30.7	8.20	-581	-39	100°	-	-39
H 31.7	8.25	-620	-23¾	40°	-	-23¾
G. 1.8	8.22	-643¾	stopped	100°	-	—
H. 2.8	8.20	-[illegible]				

Date	Time	Error	Rate	Temp	Lie	Rate for 24 hrs
# 3.8	8.25	-21½	-20½	80°	D.U.	-21½
4.8	8.15	-47	-25½	80°	"	-25½
5.8	9.30	-85½	-38½	80°	P.U.	-36½
6.8	8.15	-123½	-37	80°	-	-37
7.8	8.25	-163	-26½	80°	D.U.	-26½
8.8	8.20	-165	-22	76°	D.U.	-22
9.8	8.15	-185	-20	77°	D.U.	-20
10.8	8.15	-224	-39	70°	P.U.	-39
11.8	8.10	-259	-35	76°	P.U.	-35
12.8	10.00	-294½	-37½	80°	D.U.	-35
13.8	8.15	-327	-32½	78°	P.U.	-33
14.8	8.20	-359½	-17½	80°	D.U.	-17½
15.8	8.20	-379½	-35½	80°	-	-35½
16.8	8.20	-402½	stopped	80°	-	—
17.8	8.25	+17.33¾	+18½	82°	-	+18½
	9.35	+155½	stopped			
18.8	8.20	+324½	-911	82°	-	-85¾
19.8	10.20	-581	-92½	82°	-	-84½
20.8	8.20	-1314	-733	82°	-	-82¾
	12.05	-1682½	-368½			
21.8	8.20	+920	+2602¾	80°	-	+2080¾
22.8	8.25	+2086½	-511½	78°	-	-511½
	11.35	stopped				

Watch No 7 Elgin #3,013,718 sent to N.Y. 2.7.88 + exchanged for #3,013,719 8.8.50. (16)

	Date	Time	Error Corr. Corr.	Rate	Temp	Bed	Rate for 24 hrs		Date	Time	Error	Rate	Temp	C	Rate for 24 hrs
February	28.6.	13.25	+94	stopped	66°	D.U.	—		3.8	8.15	+99½	+36½	80°	D.U.	+363½
	29.6.	8.40	−39½						4.8	8.15	+113¾	+37½	80°		+337½
	30.6.	8.40	—	stopped	66°	-	—		5.8	9.20	−08	stopped	80°		—
	1.7	10.00	—	stopped	69°	-	—		6.8	8.15	+94	+102	80°		+107½
	2.7	18.10	+17	+17	70°	-	+17		7.8	8.25	+93½	+1½	80°	D.U.	+1½
	3.7	8.20	+34						8.8	8.20	+132	+36½	76°	D.U.	+36½
	4.7	8.30	+65½	+31½	74°	-	+31½		9.8	8.15	−035	stopped	76°	D.U.	—
March	5.7	8.40	+124½	+58½	76°	D.U.	+58½		10.8	8.15	+25½	+39½	76°	D.U.	+29½
	6.7	8.25	+156	+31½	78°	D.U.	+31½		11.8	8.10	+67½	+41½	76°	D.U.	+91½
	7.7	8.30	+208	+52	78°	D.U.	+52								
Hot	8.7	9.50	+246	+38	95°	D.U.	+36		12.8	10.00	+128	stopped	80°	D.U.	—
	9.7	8.15	+267	+21	100°	D.U.	+23½		13.8	8.15	−02½	+37½	78°	D.U.	+29½
	10.7	9.08	+310	+43	105°	D.U.	+47½		14.8	8.20	+33	+33½	80°	D.U.	+33½
	11.7	8.50	+346	+36	76°	D.U.	+39½		15.8	8.20	+67½	+34½	80°		+37½
Cold	12.7	8.25	+385½	+40½	40°	D.U.	+41½		16.8	8.20	+108	+38½	80°		+38½
	13.7	8.05	+411½	+26	40°	D.U.	+26		17.8	8.25	+146	+40	83°		+240
	14.7	8.15	+432½	+22½	40°	D.U.	+23½			9.35	+452½	stopped			
Hot	15.7	10.00	+466½	+30½	100°	D.U.	+28½		18.8	8.20	−168	+284½	82°		+302½
	16.7	8.20	+488½	+23½	100°	-	+29½		19.8	10.20	+102	+270	82°		+249½
	17.7	8.20	+515½	+27½	100°	-	+27½		20.8	8.20	+233½	+133½	83°		+145½
	18.7	8.15	+540	+24½	100°	-	+24½			12.05	−62½	−300			
	19.7	8.10	+573½	+33½	100°	-	+33½		21.8	8.20	−507	−442½	80°		−511½
	20.7	8.20	+595	+21½	110°	-	+21½		22.8	8.25	−924½	−441½	78°		−444½
Mean	21.7	8.25	+619½	+24½	78°	D.U.	+24½			11.35	−1017	−90½	78°		
	22.7	10.05	+646	+26½	78°	-	+24½		23.8	8.20	−1256½	−239½	78°		−237½
	23.7	8.25	+674½	+28½	78°	-	+30½			10.15	−1811½	−253	76°		−234½
	24.7	8.20	+708½	+32	40°	D.U.	+33		24.8	10.45	−1971	−59½	76°		
	25.7	8.20	+738½	+30	38°	-	+30		25.8	8.15	−1688½	−39½		D.U.	−42
	26.7	8.20	+768½	+31½	40°	-	+31½		26.8	10.00	−1671	−62½	76°		−58½
Cold	27.7	8.20	+797½	+29½	38°	-	+29½		27.8	8.20	−1708	−32½	76°		−34½
	28.7	8.40	+817	+29½	38°	-	+28½		28.8	8.20	−1763	−62½	76°		
	29.7	10.00	+846½	+28½	38°	-	+28½								
	30.7	8.20	+873	+28½	100°	-	+38½								
N.	31.7	8.20	+862½	+17½	40°	-	+17½								
E.	1.8	8.20	+924	+36½	100°	-	+36½								
H.	2.8	8.20	+960												

Watch No 8 Elgin # 3,0140 188 B. 6.25. (17.

Hand polished 28,1911 2 mins.

Date	Time	Error off Clock	Rate	Temp	Beat	Rate for 24 hrs
28.6	13.25	+139	stopped	66°	D.U.	—
29.6	8.40	−302½				
30.6	8.40	−32	± 1⅞	66°	..	−1⅞
1.7	10.00	+47	stopped	69°	..	—
2.7	11.00	−12	stopped	69°	..	—
3.7	8.20	−8	+4	70°	..	+4⅛
4.7	8.30	−4½	+3½	70°	..	+3½
5.7	8.40	+107	−8½	75°	D.U.	−8½
6.7	8.25	+109	+2	78°	D.U.	+2
7.7	8.30	+100	−9	78°	D.U.	−9
8.7	9.50	+82⅞	−17½	95°	D.U.	−16⅞
9.7	8.15	+84½	+1½	100°	D.U.	−1½
10.7	9.08	+80	−4½	108°	D.U.	−4½
11.7	8.50	+74	−6	116°	D.U.	−6
12.7	8.25	+66⅞	−7½	109°	D.U.	−7½
13.7	8.05	+55½	−11½	109°	D.U.	−11½
14.7	8.15	+39⅞	−15⅞	109°	D.U.	−15⅞
15.7	10.00	+44½	+4⅞	100°	D.U.	+4⅞
16.7	8.20	+46½	+1⅞	100°	.	+1⅞
17.7	8.20	+50½	+4	100°	.	+4
18.7	8.15	+47	−3½	100°	.	−3½
19.7	8.10	+45	−2	100°	.	−2
20.7	8.20	+49	+4	110°	.	+4
21.7	8.25	+49	0	78°	.	0
22.7	10.05	+50⅞	+1⅞	78°	.	+1⅞
23.7	8.25	+46⅞	−4	78°	.	−4⅛
24.7	8.20	+40½	−6½	105°	D.U.	−6½
25.7	8.20	+34	−6½	38°	.	−6½
26.7	8.20	+29	−5	60°	.	−5
27.7	8.20	+17⅞	−11⅛	35°	.	−11⅛
28.7	8.40	+05½	−12½	35°	.	−12½
29.7	10.00	+22	−7½	35°	.	−7
30.7	8.20	−10⅞	−8⅞	38°	.	−8⅞
H. 31.7	8.25	−10	+⅞	100°	.	+⅞
B. 1.8	8.20	−21	−11	100°	.	−11
H. 2.8	8.20	−29	−8	100°	.	−8

Date	Time	Error	Rate	Temp	Beat	Rate for 24 hrs
	°					
3.8	8.15	−25	+4	90°	D.U.	+4
4.8	8.15	−27	−2	90°	..	−2
5.8	9.30	−45½	−18½	80°	D.U.	−17½
6.8	8.15	−57	−12	80°	..	−14½
7.8	8.25	−66	−7	80°	D.U.	−7
8.8	8.20	−79½	−13½	76°	D.U.	−13½
9.8	8.15	−90½	−11	75°	D.U.	−11
10.8	8.15	−112	−21½	75°	D.U.	−21½
11.8	8.10	−125	−13	76°	D.U.	−13
12.8	10.00	−125½	+3½	80°	D.U.	+3½
13.8	8.15	−122	−½	78°	D.U.	−½
14.8	8.20	−133½	−11½	80°	D.U.	−11½
15.8	8.20	−133½	0	80°	..	0
16.8	8.20	−139	−5½	80°	..	−5½
17.8	8.25	−150	−11	82°	..	−11
	9.35	−709½	stopped			—
18.8	8.20	−1097½	−388½	80°	..	−388½
19.8	10.20	−1462½	−364½	86°	..	−357½
20.8	8.20	−1700½	−237½	82°	..	−232
	12.05	−2039½	−339			
21.8	8.20	−1967	+72½	80°	..	+67½
22.8	8.25	−1522½	+446½	78°	..	+436½
	11.35	−1122½	−402	78°	..	
23.8	5.20	−2017½	−899½	78°	..	−1040½
24.8	10.15	−3118½	−1101½	76°	..	−977½
	10.45	−3105	+13½		..	
25.8	8.15	−3663	−558		..	−623
26.8	10.00	−4283	−620	74°	..	−578
27.8	8.20	−4777½	−494½	..	..	
28.8	8.20	−5367	−590	..	..	−550½

Watch No 9. Hampden # 373,661 $2.50.

(18)

Date	Time	Error Stand	Rate	Temp	B	Rate for 24 hrs
28.6	13.25	+27	+19	66°	D.U	+23¾
29.6	8.40	+46	+46	66°	..	+20½
30.6	8.40	+69½	+69½			
1.7	10.00	+92	+22½	69°	..	+21½
2.7	11.00	+116	+24	69°	..	+23
3.7	8.20	+138½	+22½	70°	..	+23¾
4.7	8.30	+161	+23½	71°	..	+23¾
5.7	8.40	+186	+5	76°	D.U	+5
6.7	8.25	+191½	+23½	78°	D.U	+23½
7.7	8.30	+217	+23½	78°	D.U	+23½
8.7	9.50	+219	+2	95°	D.U	+2
9.7	8.15	+237	+18	100°	D.U	+19¼
10.7	9.08	+252	+15	105°	D.U	+14½
11.7	8.50	+253	+1	74°	D.U	+1
12.7	8.25	-24½	stopped	49°	D.U	—
13.7	8.05	-4½	+20	49°	D.U	+20
14.7	8.15	+21½	+25½	49°	D.U	+25½
15.7	10.00	+39½	+18	100°	D.U	+16¾
16.7	8.20	+46½	+7	100°	D.U	+7½
17.7	8.20	+60	+13½	100°	D.U	+13½
18.7	8.15	+76	+16	100°	-	+16
19.7	8.10	+82½	+6½	100°	-	+6½
20.7	8.20	+90½	+8	100°	-	+8
21.7	8.25	-27	stopped	78°	D.U	—
22.7	10.05	-16	stopped	78°	-	—
23.7	8.25	+2	+18	78°	-	+19¼
24.7	8.20	+26½	24½	65°	D.U	—
25.7	8.25	-15	stopped	38°	..	—
26.7	8.20	+09	stopped	65°	..	—
27.7	8.20		stopped	35°	..	—
28.7	8.40		stopped	35°	..	—
29.7	10.00		stopped	35°	..	—
30.7	8.20	+10½	stopped	35°	..	—
# 31.7	8.25	+24	+15½	100°	-	+13½
C 1.8	8.30	+10	stopped	60°	-	—
N 2.8	8.20	+26½	-9½	100°	-	-9¼

Date	Time	Error	Rate	Temp	B	Rate for 24 hrs
3.8	8.15	+46	+17¾	80°	D.U	+17¾
4.8	8.15	+60	+14	80°	..	+14
5.8	9.30	-31	stopped	80°	D.U	—
6.8	8.15	-35½	-4½	80°	..	-4¾
7.8	8.25	-23	+12½	80°	D.U	+12½
8.8	8.20	-07	+16	76°	32	+16
9.8	8.15	+13	+20	78°	D.U	+20
10.8	8.15	+07	-06	78°	D.U	-06
11.8	8.10	+12½	+5½	76°	D.U	+5½
12.8	10.00	+26	+13½	80°	30	+12½
13.8	8.15	+37	+11	78°	D.U	+11¾
14.8	8.20	+53	+16	80°	D.U	+16
15.8	8.20	+66½	+12½	76°	..	+12½
16.8	8.20	-459½	-16½	80°	..	-164½
17.8	8.25	-475½	-16½	83°	..	-16½
18.8	9.35	-2559	stopped			
	Tomb L	Arrive	2544	80°	-	
19.8						

Watch No. 10 Patek, Philippe & Co. 76,772 (19)

Date	Time	Error of Clock	Rate	Temp.	Pos.	Rate for 24 hours	Date	Time	Error	Rate	Temp.	Pos.	Rate for 24 hours
28.6	13.25	-65					3.8	8.15	-6369	-166	80°	DU	-166
29.6	8.40	+861	+181?	66°	DU	[illegible]	4.8	8.15	-6522	-173	80°	--	-173
30.6	8.40	-600	-1461	66°	DU	[illegible]	5.8	9.30	-6723	-181	80°	DU	-172
Parliament 1.7	10.00	-5941	-192½	69°	DU	-169½	6.8	8.15	-6895	-1621	80°	--	-173½
2.7	11.00	-7061	-192½	69°	-	-169½	7.8	8.25	-7063	-173½	80°	DU	-173½
3.7	8.20	-949	-162½	70°	-	-178½	8.8	8.20	-7234	-170½	76°	DU	-170½
4.7	8.30	-1131	-182	70°	-	-182	9.8	8.15	-7404½	-170½	78°	DU	-170½
5.7	8.40	-1318	-187	76°	DU	-187	10.8	8.15	-7581	-177	78°	DU	-177
6.7	8.25	-1499½	-182½	78°	DU	-181½	11.8	8.10	-7741	-159½	76°	DU	-159½
7.7	8.30	-1679½	-180½	78°	DU	-180½	12.8	10.00	-7925	-184½	80°	DU	-171½
Hot 8.7	9.50	-1862½	-183	95°	DU	-175½	13.8	8.15	-8082½	-157½	78°	DU	-168½
9.7	8.15	-2025	-162½	100°	DU	-169½	14.8	8.20	-8253	-169½	80°	DU	-169½
10.7	9.08	-2205	-180	105°	DU	-175½	15.8	8.20	-8423	-171	80°	--	-171
11.7	8.50	-2371½	-170½	76°	DU	-176	16.8	8.20	-8588½	-165½	80°	--	-165½
Cold 12.7	8.25	-2549	-177½	49°	DU	-177½	17.8	8.25	-8761	-173½	80°	--	-172½
13.7	8.05	-2728	-179	49°	DU	-179		19.35	-9392½	Stopped		--	
14.7	8.15	-2920	-192½	49°	DU	-192½	18.8	8.20	-9558	-165½	80°	--	-172½
15.7	10.00	-3097½	-177½	100°	DU	-168½	19.8	10.00	-9737	-179	80°	--	-161½
Hot 16.7	8.20	-3253	-155½	100°	-	-167	20.8	8.20	-9893	-156	80°	--	-173¼
17.7	8.20	-3423	-170	100°	-	-170	21.8	12.05	-10193	-300½		--	
18.7	8.15	-3593½	-170½	100°	-	-170	22.8	8.20	-10325	-132	80°	--	-187
19.7	8.10	-3762½	-169	100°	-	-169	23.8	8.25	-10484	-159½	78°	--	-156½
20.7	8.20	-3932½	-167	100°	-	-167	24.8	11.35	-10679	-78	78°	--	-175½
21.7	8.25	-4102	-170	78°	DU	-170		8.20	-10911	-152	75°	--	
Cold 22.7	8.05	-4267½	-165½	78°	-	-173½		10.15	-10998	-87	76°	--	-173½
23.7	8.25	-4427	-160	78°	-	-172		10.45	-10959	+61	--	--	
24.7	8.20	-4594	-167	25°	DU	-167	25.8	8.25	-11110	-151½	76°	--	-156½
25.7	8.25	-4762	-168	25°	-	-168	26.8	10.00	-11283	-163	76°	--	-152½
26.7	8.20	-4929	-167	25°	-	-167	27.8	8.20	-11439½	-156½	76°	--	-166½
27.7	8.20	-5096	-167	25°	-	-167	28.8	8.20	-11603	-163½	76°	--	
28.7	8.20	-5263	-167	25°	-	-167							
29.7	10.00	-5431½	-168½	25°	-	-168½							
30.7	6.20	-5599	-167½	25°	-	-177½							
N. 31.7	8.25	-5765	-176	100°	-	-176							
8.1.8	8.20	-6024	-179½	100°	-	-179½							
9.2.8	8.20	-6203	-179	100°	-	-179							

Watch No. 11 – My own golden one.

	Date	Time	Error @ Beh.	Rate	Temp.	Ex.	Sec.	
Rehearsing	28.6	13.25	+56½	-4¾	66°	D.U.	-4	
	29.6	8.40	+51¾	-7½	66°	-		
	30.6	8.40	+44¼	-6	69°	-	-5½	
	1.7	10.00	+38½	-5¾	69°	-	-4½	
	2.7	11.00	+33¾	-4¾	70°	-	-4	
	3.7	8.20	+29	-2	70°			
	4.7	8.30	+27	-13	76°	P.U.		
Mum	5.7	8.40	+14	-1¾	76°	D.U.		
	6.7	8.25	+12¼	-2¼	76°	D.U.		
	7.7	8.30	+11½	-11	95°	P.U.	-1½	
Hot	8.7	9.50	-22½	-3½	100°	D.U.	-3½	
	9.7	8.15	-26	-20	108°	D.U.	-10	
	10.7	9.08	-52	-13	110°	P.U.		
M.	11.7	8.50	-65	+3	49°	P.U.		
Cold	12.7	8.25	-62	-10	49°	D.U.		
	13.7	8.05	-72	-32½	49°	D.U.		
	14.7	8.15	-104½	-4¾	100°	D.U.		
Hot	15.7	10.00	-109¼	-6¾	100°	-		
	16.7	8.20	-116	-5	100°	-		
	17.7	8.20	-121	-4½	100°	-		
	18.7	8.15	-125½	-8½	100°	-		
	19.7	8.10	-134	+10	110°	-		
	20.7	8.20	-124	-18	78°	D.U.		
Mum	21.7	8.25	-142	-6½	78°	-		
	22.7	18.05	-148½	Remarks				
	23.7	8.25	-	-				
	2							

Watch No 12 Pallard. # 55821 Property of Mr Starr. (21)

Date	Time	Error Clock	Rate	Temp	Dial	Rate for 24 hrs
18.7	11.23	+4½	-17½	100°	D.U.	-15½
19.7	8.10	-8	-22	110°	D.U.	
20.7	8.20	-30	-25½	78°	D.U.	
21.7	8.25	-55½	-25	78°	D.U.	-24½
22.7	10.05	-80½	-20½	78°	D.U.	-22
23.7	8.25	-101	-23	45°	D.U.	
24.7	8.20	-124	-24½	38°	-	
25.7	8.20	-148½	-24½	45°	-	
26.7	8.20	-173	-25½	35°	-	
27.7	8.20	-198½	-25½	35°	-	
28.7	8.40	-224	-27	35°	-	-25½
29.7	10.00	-251	-24½	38°	-	-26
30.7	8.20	-275½	-26½	100°	-	
H 31.7	8.25	-302	-25	40°	-	
B. 1.8	8.20	-327	-27	100°	-	
H. 2.8	8.20	-354	-26½	80°	-	
3.8	8.15	-380½	-37½	80°	-	
4.8	8.15	-405	-36	80°	D.U.	-34½
5.8	9.30	-441½	-28½	80°	-	
6.8	8.15	-475	-30	80°	D.U.	
7.8	8.25	-505	-32	76°	D.U.	
8.8	8.20	-537	-33	78°	D.U.	
9.8	8.15	-570	-31	78°	D.U.	
10.8	8.15	-601	-31½	76°	D.U.	
11.8	8.10	-6023	-33½	80°	D.U.	-31
12.8	10.00	-676	-39	76°	D.U.	-31½
13.8	8.15	-705	-32	80°	D.U.	
14.8	8.20	-737	-31	80°	-	
15.8	8.20	-768	-32½	80°	-	
16.8	8.20	-800½	-32½	80°	-	
17.8	8.25	-833	+10	8	-	
18.8	9.35	-823	-32	81°	-	-33½
19.8	8.20	-855	-36½	82°	-	-34½
19.8	10.20	-891	-32	82°	-	-35
20.8	8.20	-923	-26½		-	
	12.05	-1140	-25	80°	-	-33½
21.8	8.20	-1215				

Date	Time	Error Clock	Rate	Temp	Dial	Rate for 24 hrs
21.8	8.20	-1215	-34	76°	D.U.	
22.8	8.25	-1253	-40	76°	-	
	11.35	-1295				
23.8	8.20	-1297½	-31½	77°	-	-34
24.8	10.15	-1330½	-37½	76°	-	-35
	10.45	-1327	-42	76°	-	
25.8	8.15	-1359	-32	76°	D.U.	
26.8	10.00	-1397½	-38½	76°	-	-36
27.8	8.20	-1431	-33½	-	-	-35½
28.8	8.20	-1476	-45	-	-	

47) 10 4 13

1 1¾

Doubtful as hand had evidently engaged.

Watch No 13 Property of T. B. Starr. Maker T. B. Starr

Date	Time	Error by Clock	Rate	Temp	Pos	Rate for 24 hrs.
20.7	11.30	+20				
			+14s	78°	DU	+16½
21.7	8.15	+34				
			+29⅓	78°	DU	+27½
22.7	10.05	+63⅓				
			+10⅓	78°	DU	+11½
23.7	8.25	+74				
			−15	65°	DU	
24.7	8.20	+59				
			+33	38°	-	
25.7	8.20	+92				
			−08	25°	..	
26.7	8.20	+84				
			−20¾	35°	..	
27.7	8.20	+63¾				
			+3¾	25°	..	
28.7	8.40	+67				
			+10	25°	..	+5½
29.7	10.00	+77				
			−05	28°	..	−06
30.7	8.20	+72				
			−22	10°	..	
#31.7	8.25	+50				
			+ ½	60°	..	
E. 1.8	8.20	+19½				
			+3¾	10°	..	
H. 2.8	8.20	+23				
			+2½	90°	..	
3.8	8.15	+25½				
			0	80°	..	
4.8	8.15	+25½				
			stopped	80°	D.U	
5.8	9.30	−07				
			stopped	80°	..	
6.8	8.15	+01				
			stopped	80°	D.U	
7.8	8.25	+15				
			stopped	76°	D.U	
8.8	8.20	−21				
			+01	72°	D.U	
9.8	8.25	−20				
			stopped	72°	D.U	
10.8	8.15					
			stopped	76°	D.U	
11.8	8.10					
			stopped	80°		
12.8	10.00					

Watch No 16 Property of T. B. Starr Maker Elgin C. # 942,025

Date	Time	Error Stick	Rate	Temp	Bar	Rate by Mt.	Date	Time	Error Stick	Rate	Temp	Bar	
20.7	11.30	+9½	+41½	78°		[illegible]	25.8	8.15	+1760	+71	74°	20.	+ 6 6/4
21.7	8.25	+39¾	+30	78°		+49½	26.8	10.00	+1831	+59	74°		+ 6 3/2
22.7	10.25	+100¾	+45	78°		+48½	27.8	8.20	+1890	+51	74°		
23.7	8.25	+146¾	+40½	65°	20.		28.8	8.20	+1941				
24.7	8.20	+186½	+35½	85°									
25.7	8.20	+222	+38	85°									
26.7	8.20	+260	+34½	85°									
27.7	8.20	+294½	+37½	85°									
28.7	8.20	+332	+39	85°		-37							
29.7	10.00	+371	+26½	81°		+57							
30.7	8.20	+407½	+45½	100°									
H 31.7	8.25	+452½	+36½	100°									
C 1.8	8.20	+489	+42½	100°									
H. 2.8	8.20	+531½	+46	80°									
3.8	8.15	+577½	+44½	80°									
4.8	8.15	+622	+55½	80°	20.	+52½							
5.8	9.30	+677½	+47½	80°		+47½							
6.8	8.15	+725	+50½	80°	20.								
7.8	8.15	+775½	+45½	76°	20.								
8.8	8.20	+821	+46	76°	20.								
9.8	8.15	+873½	+52½	75°	20.								
10.8	8.15	+925	+47	75°	20.								
11.8	8.10	+972	+38½	80°	20.	+35½							
12.8	10.00	+1010½	+69½	75°	20.	+59½							
13.8	8.15	+1080	+[illegible]	80°	20.								
14.8	8.20	+1134½	+59	76°									
15.8	8.20	+1193	+65	79°									
16.8	8.20	+1258	+86	80°									
17.8	8.25	+1323	+62	80°									
18.8	8.20	+1385	+48½	80°		+42½							
19.8	10.20	+1433½	+49	80°		+42½							
20.8	8.20	+1525	+54	78°									
21.8	8.20	+1579	+56	78°									
22.8	8.25	+1635	+48½	78°		+39½							
23.8	8.20	+1683½	+51½	74°		+46½							
24.8	10.15	+1735	+50	74°		+46½							
25.8	8.15	+1760											

Watch No. 15 Property of T. B. Starr. Howard Maker, # 62, 615

Date	Time	Error Watch	Rate	Temp	Ba	Rate for 24 hrs	Date	Time	Error Watch	Rate	Temp	Ba	
20.7	11.30	-42					25.8	8.15	-09	-03	74°	Bu	-2¾
21.7	8.25	-42¾	+1¼	78°	DD		26.8	10.00	-12	-03	-	-	
22.7	10.05	-43	-½	78°	-		27.8	8.20	-15	-03	-	-	-3¼
23.7	8.25	-41	-2	75°	-	-2¼	28.6	8.20	-18				
24.7	8.20	+153¾	+104¾	65°	DU								
25.7	8.20	-26	stopped	35°	-								
26.7	8.20	+07½	stopped	65°	-								
27.7	8.20		stopped	35°	-								
28.7	8.140		stopped	35°	-								
29.7	10.00		stopped	35°	-								
30.7	8.20	+25½	+5½	60°	-								
H 31.8	8.25	+31	+5½	10°	-								
B. 1.8	8.20	+31½	-3	10°	-								
H. 2.8	8.20	+28½	+½	80°	-								
3.8	8.15	+29	-½	80°	-								
4.8	8.15	+25	-3½	80°	DU								
5.8	9.30	+21½	+½	80°	-								
6.8	8.15	+22	-2	80°	Bu								
7.8	8.25	+20	-2¾	76°	DD								
8.8	8.20	+17¼	-½	78°	DD								
9.8	8.15	+17	+4	78°	DU								
10.8	8.15	+21	+6½	76°	DU								
11.8	8.10	+27½	-2	77°	DU								
12.8	10.00	+25½	-2	76°	DU								
13.8	8.15	+23½	-2½	76°	DU								
14.8	8.20	+21	-2	76°	-								
15.8	8.20	+19	-2	77°	-								
16.8	8.20	+17	-3	80°	-								
17.8	8.25	+14	-3	80°	-								
18.8	8.20	+11	-2¾	80°	-								
19.8	10.20	+08½	-2¾	80°	-								
20.8	8.20	+06	-3	80°	-								
21.8	8.20	+03	-04	78°	-								
22.8	8.25	-01	-02½	75°	-								
23.8	8.20	-03½	-02¼	76°	-	-3¼							
24.8	10.15	-06	-03	74°	-	-3¼							
25.8	8.15	-09											

Watch No 16 Property of T. B. Stow Andermain number # 13,266

25

Date	Time	Error Clock	Rate	Temp	Bal	Auto ff. w.w.
20.7.	11.30	-8½				
21.7	8.25	-7	+1½	78°	DU	+1¾
22.7	10.05	-7	0	78°	DU	
23.7	8.25	-7½	-½	78°	DU	
24.7	8.20	-9½	-1¾	65°	DU	
25.7	8.20	-13	-3½	38°	-	
26.7	8.20	-16	-3	45°	-	
27.7	8.20	~~-21~~	-5	35°	-	
28.7	8.40	-27½	-6½	35°	-	
29.7	10.00	-34½	-7	35°	-	-6¾
30.7	8.20	-38½	-4	38°	-	-4¼
W 31.7	8.25	-40½	-1½	100°	-	
R 1.8	8.20	-43½	-3½	105°	-	
W. 2.8	8.20	-47	-3½	100°	-	
3.8	8.15	-44½	+2½	80°	-	
4.8	8.15	-46½	+1¾	80°	-	
5.8	8.20	-39½	+5½	80°	DU	+5½
6.8	8.15	-36½	+3½	80°	-	
7.8	8.25	-36	+½	80°	DU	
8.8	8.20	-40	-4	76°	DU	
9.8	8.15	-42	-2	78°	DU	
10.8	8.15	-42	0	78°	DU	
11.8	8.10	-43	-1	76°	DU	
12.8	10.00	-42½	+0½	77°	DU	
13.8	8.15	-42½	-½	78°	DU	
14.8	8.20	-42½	+½	78°	DU	
15.8	8.20	-43	-½	76°	-	
16.8	8.20	-45	-2	79°	-	
17.8	8.25	-45	0	80°	-	
18.8	8.20	-44	+1	80°	-	
19.8	10.20	-44½	-½	80°	-	
20.8	8.20	-45	-½	80°	-	
21.8	8.20	-44½	+½	80°	-	
22.8	8.25	-45	-½	79°	-	
23.8	8.20	-47	-2	79°	-	
24.8	10.15	-46½	-1½	76°	-	
25.8	8.15	-48	+½	76°	-	

Date	Time	Error Clock	Rate	Temp	Bal	Auto ff. w.w.
25.8	8.15	-48	-01	74	DU	
26.8	10.00	-49	+02	-	-	+2½
27.8	8.20	-47	+01	-		
28.8	8.20	-46				

Watch No. 17. Property of T. B. Starr. Waltham G. # 2642, 805.

(26)

Date	Time	Error of Clock	Rate	Temp	Ba	Error of Clock 8a. 24th	Date	Time	Error of Clock	Rate	Temp	Ba	
20.7.	11.30	-28½	-16½	72°	30	-18¾	25.8	8.15	-119	-09	74°	30	-8½
21.7	8.25	-44¾	-9¾	78°	-	-9	26.8	10.00	-128	-09	-	-	-8½
22.7	10.05	-52½	-6½	78°	-	-7	27.8	8.20	-136	-08	-	-	
23.7	8.25	-61					28.8	9.20	-144				
24.7	8.20	-63	-2	80°	30								
25.7	8.20	-66	-3	85°	-								
26.7	8.20	-68½	-2½	85°	-								
27.7	8.20	-74	-5½	85°	-								
28.7	8.40	-85	-11	85°	-								
29.7	10.00	-95½	-10½	85°	-	-9							
30.7	8.20	-102	-6½	85°	-	-7							
H 31.7	8.25	-119	-17	100°	-								
1.8	8.20	-129	-10	100	-								
H. 2.8	8.20	-146	-17	100°	-								
3.8	8.15	-154	-8	80°	-								
4.8	8.15	-163½	-9½	80°	-								
5.8	9.30	-180	-16½	80°	30	-15¾							
6.8	8.15	-196	-16	80°	-	-17							
7.8	8.25	-205½	-9¾	80°	30								
8.8	8.20	-218	-12½	78°	30								
9.8	8.15	-234	-16	78°	30								
10.8	8.15	-244	-10	78°	30								
11.8	8.10	+09	stopped	78°	30								
12.8	10.00	+0½	-9½	78°	30	-8							
13.8	8.15	-9	-9½	78°	30	-10¼							
14.8	8.20	-18½	-9½	78°	30								
15.8	8.20	-28	-9½	78°	-								
16.8	8.20	-37	-9	79°	-								
17.8	8.25	-46	-9	80°	-								
18.8	8.20	-55½	-9½	80°	-								
19.8	10.20	-65	-9½	80°	-	-9							
20.8	8.20	-73	-8	80°	-	-8¾							
21.8	8.20	-82½	-9½	80°	-								
22.8	8.25	-91½	-9	78°	-								
23.8	8.20	-100	-8½	78°	-								
24.8	10.15	-111½	-11½	78°	-	-10¼							
25.8	8.15	-119	-7½	78°	-	-8¾							

39) 5-10.5 - 39 120 1.3.5-U | 1309

5-3) 2129.75 | 4018 97 53 745

Watch No. 18 Property of T. B. Starr Nattham C. N. 228, 1-314

Date	Time	Error by Clock	Rate	Temp	Ex	Rate for 24 hrs	Date	Time	Error by Clock	Rate	Temp	Ex	Rate for 24 hrs
20.7	11.20	-28"	-8	78°	DU	-9¼	22.8	11.35	-901	-27	75°	..	-31¼
21.7	8.25	-36	-9½	78°	DU	-9	23.8	8.20	-928	-28	76°	..	-26
March 22.7	10.05	-465¼					24.8	11.15	-956	-28	76°	..	
								10.45	-1000	-4.4	76°	DU	
23.7	8.25	-58¼	-13	78°	DU	-14	25.8	8.15	-1025	-25	74°	DU	-28
24.7	8.20	-664	-7¾	45°	DU		26.8	10.00	-1057	-32	74°	..	-29¾
25.7	8.20	-80	-13¾	38°	..		27.8	8.20	-1084	-27	74°	..	-29
26.7	8.20	-96	-16	45°	..		28.8	8.20	-1110	-26			
27.7	8.20	-111¼	-15¼	35°	..	-17½							
28.7	8.40	-124	-12¾	35°	..								
29.7	10.00	-142¼	-18¼	35°	..	-15¾							
30.7	8.20	-157	-14¾	35°	..								
# 31.7	8.25	-176¼	-19¾	100°	..								
April 1.8	8.20	-19	157¼	80°	..								
# 2.8	8.20	-35	-16	100°	..								
3.8	8.15	-49	-14	50°	-								
4.8	8.15	-69	-20	50°	-								
5.8	9.20	-112¾	-43¾	80°	DU	-43¾							
6.8	8.15	-158¾	-44	80°	..	-46¼							
7.8	8.25	-177	-19¼	80°	DU								
8.8	8.20	-201	-23	76°	DU								
9.8	8.15	-216	-15	78°	DU								
10.8	8.15	-267¼	-51¼	78°	DU								
11.8	8.10	-295	-27¾	76°	DU								
12.8	10.00	-314	-19	80°	DU	-17¾							
13.8	8.15	-336¾	-20¾	78°	DU	-22¼							
14.8	8.20	-352	-19¾	80°	DU								
15.8	8.20	-377	-25	76°	..								
16.8	8.20	-401	-22	78°	..								
17.8	8.25	-423¼	-22½	78°	..								
	9.35	-426¼	-3		..								
18.8	8.20	-423¼	+2.9	80°	..	-DU							
19.8	10.20	-453	-29½	80°	..	-27¾							
20.8	8.20	-479¾	-26¾	82°	..	-27¾							
)	12.05	-502	-32½										
21.8	8.20	-522	-20	80°	..	-23¾							
22.8	8.25	-557	-36	78°	..								
	11.35	-901	-43	78°	..								

Received 7 Watches from Mr T. B. Starr of N.Y. about the 12th July. Wanted to communicate with Mr Ward about these. On receipt of letter of the 19th July from Mr Ward saying that he wished these tested took them out of the safe. As 5 of them had gold cases, requested Mr Starr to remove these and replace them with glass ones. This he did on the 20th.

The Watches he left in our charge are as follows

No.	Our Local Number	Maker	Maker's Number	Case
1	12	Non Mag Co	55821	Watchmakers
2	13	T. B. Starr	Under face plate	do.
3	14	Elgin Co	942,025	do
4	15	Howard	62,615	do
5	16	Audemars	~~2,142~~ 13,266	do
6	17	Am. Wat. Co	2,642,805	Golden.
7	18	Am. Wat. Co	225,434	Silver.

The first and last, our nos. 12 and 18 are for magnetic test. The others are for rate comparisons only.

Bordier Voltmeter repaired with 4 metres (roughly) of platinum iridium wire 0.002" Res. 700 ω.

30° no indicate	56.3 volts
40°	67
50°	70.5
60°	88.5
70°	90.5
80°	97
90°	107
100°	111.5
110°	125.5
115°	129

Calculation for the length and weight of wire we shall need for the Edison Voltmeter, and also for the sheet shunt of Platinoid.

We know that we shall need some 50 metres of wire 0·018" diam (0·045 cm) see book 2 page 16. for each voltmeter. The area of this wire is 0·00159 sq. cms which × 5000 = $1.59 \times 10^{-3} \times 5 \times 10^{3}$ = 7·95 sq. cms. volume. The spec. gr. being 8·5 makes the mass 67·6 grammes. = 0·15 lbs: so that, it should be enough for 6½ voltmeters.

1000 amperes or 100 units of current flowing through a strip of platinoid t centimetres thick and w centimetres wide, gives an average current of $\frac{100}{tw}$ per sq. cm. of section. The strip for every cm. of its length will have reflecting the edge 2w sq. cms of surface. so that the surface per sq cm will be $\frac{2w}{tw}$ or $\frac{2}{t}$. Now neglecting convection the energy developed by the current will be

$$\frac{4 \cdot 03 \times 10^{4} \times 100^{2}}{t^{2}w^{2}} \text{ or in Heat units}$$

$$\frac{4 \cdot 03 \times 10^{4} \times 10^{4}}{4 \cdot 16\, t^{2}w^{2} \times 10^{3}} = \frac{40 \cdot 3}{4 \cdot 16\, t^{2}w^{2}} = \frac{9 \cdot 69}{t^{2}w^{2}}$$

The heat radiated per sq. cm = $\frac{2\theta \times 2 \times 10^{-4}}{t}$ per cm.

$\therefore\ 9.69\, t = 4\, t^{2}w^{2}\theta \times 10^{-4}$ assume $\theta = 1°$ C.

$\therefore\ 2.42 \times 10^{4} = t\, w^{2}\theta$

$\therefore\ w^{2}t = 2.42 \times 10^{4}$

$\therefore\ w^{2} = \frac{2.42 \times 10^{4}}{t}$

$\therefore\ w = \frac{1.55 \times 10^{2}}{\sqrt{t}}$

1/16" = 0·0625" = 0·159 cms. $\sqrt{159}$ = 0·4

$6.56 \div 0.4$ = 3.9 × 10 = 39 cms wide = 1/16" wide

Every cm. of length will have an area of $6'' \times \frac{1}{16}$. $= \frac{15.24 \times 0.159}{}$ sq. cm $= 2.423$ sq. cm
or 2.423 c.c. volume $\times 9.5 = 20.6$ grammes.
so that each inch will weigh $20.6 \times 2.54 = 52.3$ grammes $= \frac{52.3}{454.6} = 0.115$ lbs. so that 9" go to the lb. approx.
The res. of one strip is $\frac{4.03 \times 10^{4}}{2.423}$ res. per cm.
$= 1.66 \times 10^{4} = 1.66 \times 10^{-5}$ ohm.
The res. of 30 cms will then be 4.98×10^{-5}
$= 0.000049$ ω the difference of potential between the ends at 40 amps. current $= 5 \times 10^{-4} \times 4 \times 10^{1}$
$= 20 \times 10^{-3} = 0.02$ volt. To get 0.05 volt requires 75 cms. $= 30''$
25 strips of 30" $= \frac{25 \times 30}{9}$ lbs. roughly $= \frac{750}{9} =$ 83.3 lbs say 84 lbs @ 45 ct $= \$37.80$.

Siemens Alternating Dynamo.

All the 16 magnet coils (8 on each circle) in series Res. 1.3 ω.

a and d are connected to 1.
b goes to 2
c goes to 3

Resistance of plating armature.
Pole Insulated 7" pulley 5.28 volts
Pole Connected through 1.4 ω

$\frac{4.9}{.38}$: $4.9 : x :: 1.4$
$x = 0.1$ ω

Some (bad contact - evidently) in circuit.

Physiological - Experiments Continued

Saturday 21st July.

Yellowish brown bitch — Weight 41½ lbs.
Length 37
Height 22
Reg. 8700

Tried effect of induction coil supplied by 5 volt dynamo. Dog bandaged on opposite leg as usual. 1st coil. Small one ½" spark.

21.05. Current on for 7 seconds.
Dog struggled but unhurt.
Took 2nd Coil that used by Schulze Berge for his vacuum depositing. 1½" spark full.

21.13. Current on for 5 second.
Dog struggled violently but unhurt.

21.25. Took large black induction coil giving about 1" spark very vivid one. Contact made & broken by mercury interrupter. Contact made for 5 secs. Dog struggled but unhurt. Placed wet pads under and in the ears, and used these as electrodes. Contact made as before. Dog struggled violently and got free quite unhurt though much excited. Obliged to discontinue experiments, for want of power.

Employed Siemens alternating dynamo making 1080 revs. per min. = 18 revs. per sec. = 18 × 8 × 2 = 288 alternations per sec.

First supplied its field magnets from the plating dynamo, but found the field quite insufficient, only about 40 volts from the set.

Used the transformer described on page 9 with some 100 in the primary cct. and some 1500 in the secondary, some four times the number of turns.

Cardew voltmeter employed for measuring voltage either directly or in cct. with lamps. Primary cct. voltage about 123 with some 10 amperes in the field circuit. Secondary cct. 125 volt when 6 lamps hot in series with voltmeter. Say each lamp has 200 ω = $\frac{1200 + 700}{700} \times 125$ = 340 volts.

Same dog as that mentioned in Saturday's experiment on the preceding page. Resistance between leg bandages as usual 14,000.

21.15. Mr Batchelor present.

Voltage before making contact about 140 volts with 6 lamps = $\frac{19}{7} \times 140$ = 380 volts.

21.25 Made contact for 5 secs: in primary cct. secondary on dog and voltmeter cct. as shunt. Voltage 191 volts with 6 lamps = 247
reproduced by 136 - - 3 - = 252
by mean say 250 volts.

Dog uttered no sound, muscles convulsed, but no struggling and died almost instantly. No struggling after current off beyond muscular twitching.

1 B.C. thro' 0.5 f = 112.0
112.0
@ 21°C = 1.43114 volt. 112.0
112.

Mean temp. of the room 21.39° C.

After observation:

1 B.C. thro' 0.5 f 114.5
115.0
@ 22.1°C = 1.4301 115.1
115.2
114.95

$$\mathcal{L} = \frac{d \times 0.715375 \times 5253 \times 10^{5}}{113.475 \times 46.57} = 71.1107\,d$$

Resistance results 19th July 1888 0.7f J.B.D.

Time	Volts	Ohms	Osc. B.	Amperes	Thermo	Corrected	Adjusted Mean	$\mathcal{L}$
9.50	118.2	32.4298	Earlier 0.1	197.6	10.0	10.0	9.6	683
.54	118.5				9.	9.0		
10.00	118.8				9.8	9.8		
.06	117.9	12.4307	0.2	375.2	18.	18.0	18.1	1287
.09	118.6				18.2	18.2		
.15	118.2	2.850	0.4	750.2	37	37	37.	2631
.17	118.8				37	37		
.27	118.2	103	7°.45'	1876	85.5	85.85	85.54	6083
.32	118.8		7°.47'		85.2	85.20		
.36	117.8	70.89	11°.35'	2811	115	115	115.6	8220
.39	118.2		"		116	116		
.42	119.3		"		115.8	115.8		
.46	118	52.078	15°.20'	3752	137.8	137.41	138.0	9813
.49	117.6		15°.15'		139	139.4		
.52	118.9		15°.25"		138.5	137.3		
.57	119.1	34.739	18°.55'	4690	182	187.6	187.9	10,802
11.01	118		18°.55'		182.5	182.1		
.06	117.3	32.147	22°.20'	5526	158.5	157.2	156.5	11,129
.10	117.5		22°.26'		157	156.7		
.14	117.2		22°.45'		158	156.5		
.24	117.1	23.072	28°.40'	7504	168.3	166.3	167.9	11,939
.28	117.1		"	"	167.5	167.5		
.32	119.0				168.0	166.0		
.42	116.6	17.29	34°.15'	9380	172.5	173.2	173.	12,302
.46	117.1		34°.20'		173	173.1		
.50	115.9		34°.15'		172	172.6		
13.13	115.3	13.508	39°.20'	11256	178	178.1	179	12,728
.20	116.1		39°.15'		179	179.7		
.25	116.4		39°.10'		178	179.2		
.32	116.6	11.517	43°.45'	13152	183.5	183.4	183.2	13,930
.38	116.6		43°.45'		183	182.9		
.49	116.5	8.019	47°.20'	15008	186.9	186.9	186.8	13,283
.53	116.6		"		186.5	186.6		
14.23	116.1	—	50°.25'	16884	188.5	188.8	189.97	13508
.27	115.3		50°.20'		190.5	190.8		
.30	116.3		50°.25'		190	190.3		
.35	115.7	5.446	53°.50'	18760	192.3	192.3	192.2	13,667
.40	116.1		53°.50'		192	192.		
.61					R.D. 0.62			
.64					Current off	R.D. 0.7		

Plating dynamo now gives 5·60 volts at normal speed with 7" wooden pulley. At first when at work on 1·35 v the P.D. at brushes fell to 5·45 indicating 0·037 v in the armature and brushes. After cleaning the brushes and commutator the P.D. rose to 5·57 v indicating 0·015 v, and necessity for further cleaning

---

Res: of Gardner voltmeter = 697·5 v @ 50° F

3 Resistances wound to put in circuit with it in order to use it with higher voltages —

Some 36 feet of the same platinum iridium wire 0·002" = 0·00508 cm.

1st length	702 v		
2nd "	716	=	14·18 ohms
3rd "	703	=	21·21 "

The indications of the instrument were checked again as follows:—

30°	54·5 volts
40°	62·7 "
50°	74·5 "
60°	84 "
70°	90 "
80°	97·5 "
90°	106·5 "
100°	112 "
110°	119 "
118°	131 "

Tried the effect of current on the wire to ascertain its carrying capacity :—

at 0·2 amperes When checked up but no burning visible

0·3 " Wood work being charred not visibly but by sense of smell.

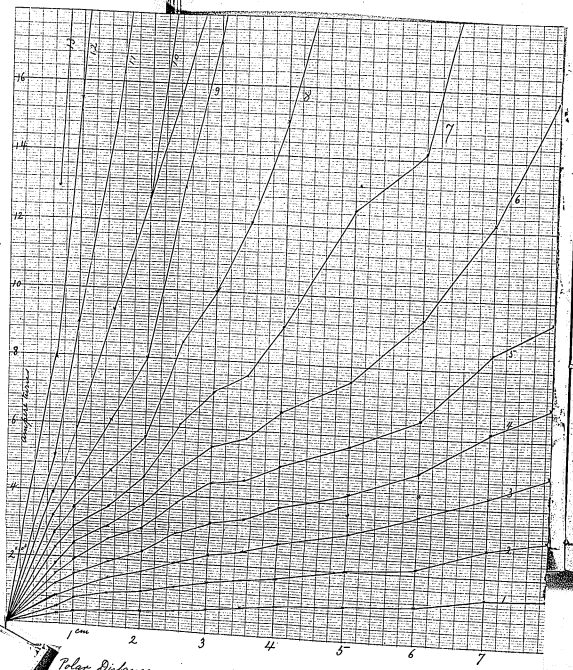
When current taken off wire partly tightened.

0·35 amp faint red heat. 0·5 amperes, this gave way down to low end

0·36 " Distinct red heat.

0·40 " Glowing red hot. 0·2 is the safe limit to employ.

0·45 " White hot, burning wood.



Pendulum Magnetic Results.

Since $\mathcal{L} = f(c\ d\ r)$

where c = current strength

d = interpolar dist.

r = magnetic resistance of iron

but $r = \phi(\mathcal{L})$

$$\therefore \frac{d\mathcal{L}}{dc} = \frac{f'\{c, d, \phi(\mathcal{L})\}}{dc} + \frac{f'\{c, d, \phi(\mathcal{L})\}}{dd}\frac{dd}{dc} + \frac{f'\{c, d, \phi(\mathcal{L})\}}{d\phi(\mathcal{L})}\frac{d\phi(\mathcal{L})}{d\mathcal{L}}\frac{d\mathcal{L}}{dc}.$$

The second term here vanishes and we have

$$\frac{d\mathcal{L}}{dc} = \frac{f'\{c, d, \phi(\mathcal{L})\}}{dc} + f'\{c, d, \phi(\mathcal{L})\}\frac{d\phi(\mathcal{L})}{d\mathcal{L}}\frac{d\mathcal{L}}{dc}$$

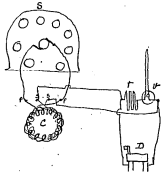
$$\text{or } \frac{d\mathcal{L}}{dc}\left\{1 - f'\{c, d, \phi(\mathcal{L})\}\frac{d\phi(\mathcal{L})}{d\mathcal{L}}\right\} = \frac{f'\{c, d, \phi(\mathcal{L})\}}{dc}$$

To more easily derive this equation let us make $\phi(\mathcal{L})$ constant by keeping to single constant value of $\mathcal{L}$, in which case the equation becomes

$$\frac{d(\mathcal{L})}{dc} = \frac{f'\{c, d\}}{dc}$$

The accompanying sheet plots the relation between the exciting power (ampere-turns $\times 10^3$) as ordinate and Interpolar distance as ordinate. The different lines correspond to the different constant values of $\mathcal{L} \times 10^3$. This not gives the curve for 1000 lines per sq cm. Allowing for dispersion of the lines at large interpolar distances the curves are approximately straight lines. That is to say $X = ad + b$ where X is exciting force d is the interpolar dist a a constant and b a constant depending on the magnetic resistance

The curves are incorrectly drawn through the origin, and the sheet will require revision



S Siemens machine making about 1050 revs per min. excited by No 20 Machine.

C Converter

r inductancebox resistance

v Bardeen voltmeter

D Dog.

Evening Tuesday 24th July. Mr Brown present.

Foxhound Dog Weight 56 lbs:

Length tip of nose to base of tail 39"

Height 23"

Res: between bandages on legs 27,500

Bandages of wet cotton waste on opposite fore and hind legs.

Used alternating Converter, described previously

Voltage in 2ndary ct: before closing dog circuit 181 volts.

21.50 Contact in primary ct. for 5 secs.

Indicated voltage 158 in 2ndary.

Result:- Dog motionless and silent. No struggling after current off. Dropped dead almost instantly.

Red Setter Weight 59 lbs:

Length tip of nose to base of tail 39"

Height 24"

Res. 5000 ω. between bandages on legs.

Volts before contact 120 in 2ndary

21.53 Contact in primary ct for 5 seconds.

Indicated volts 99.

Result dog gave one slight yelp while current on, after removal of current barked, dropped and struggled, but recovered in about 30 secs: Evidently hurt.

22.22. Volts before contact 182 in 2ndary

Contact for 5 seconds. Indicated voltage 114.

Result:- dog) silent during contact but at cessation barked and struggled violently. Bitches loose partly and got out of box.

Much hurt and exhausted.

22·30 Voltage before current on dog 190 in 3rd 37.
Contact for 5 secs: Voltage indicated 146.
Result:- Dog silent during shock but howled and struggled afterwards, unable to stand, long.

22·33 Voltage before current applied 204.
Contact for 5 secs: Voltage indicated 176.
Result:- Dog silent during contact but howled feebly afterwards. Panting and sweating very much.

22·36 Voltage before current applied 260.
Contact for 5 secs: Voltage indicated 188.
Dog silent and motionless died without struggle.

Epitome of Physiological Experiment

No. of Expt.	Description of Dog	Length in	Height in	Weight lbs.	Electrodes applied to	Electrode contact	Current employed	Voltage on dog before shock	Duration of current	Amount of current in dog	Number of applications of shock	Time elapsing before death
1	Small black terrier	–	–	–	R. ear & L. hind leg	Tinfoil	Direct	800	2	3/4 L	1 Fatal	Second min
2	Terrier	–	–	–	do.	Bare	alternate 25	800	3	—	3 Fatal	within 30 sec
3	Fox terrier	26"	13"	13½	do	Tinfoil	Direct	1000	Momentary	0·25	5 Fatal	in 2 mins
4	Bull dog	37"	21"	46½	do	Tinfoil	alternate 25	800	2½	0·1	1 Fatal	in 15 secs
5	Black Terrier	33½"	23½"	39	do	Tinfoil	Direct	1000	2½	0·37	6 Not fatal	—
6	Black mongrel	35"	21"	55	do.	Tinfoil	alternate 25·3	870	3	—	3 Fatal	in 90 secs
7	Yellow "	28½"	18"	35	do	Tinfoil	Direct	500	4	0·025	0 Fatal	in 5 mins
8	Bull terrier	46"	23"	47	Head	Tinfoil	alternate 16	300	4	—	1 Not fatal	—
							"	1200	4	1·2	3 Fatal	in 15 secs
9	Yellow mongrel	37"	22	41½	R. Fore & L. hind leg	Tinfoil	Alternate 25·3	250	5	—	0 Fatal	at once
10	Terrier	30"	23"	56	do	Tinfoil	do.	158	5	—	0 Fatal	at once
11	Setter	34"	26"	59	do	Tinfoil	do	188	5	—	0 Fatal	at once

Cell no 1

Date	Time	Hour	B.Bent	EMF	I.R.	G.		
26.7.	9.0	0	1.704	1.164	0.193			
	9.30	½	0.930	0.548	0.089			
	12.00	3	0.936	0.570	0.104			
	18.00	9	0.012	0.360	0.073			
27.7	8.0	23	0.992	0.546	0.050			
	12.00	27	0.980	0.534	0.048			
	18.00	33	0.980	0.546	0.057			
28.7	8.00	47	0.936	0.469	0.055			
	18.00	57	0.848	0.470	0.055			
30.7	8.00	95	0.840	0.467	0.055			
	The weight of the zinc after test was jointly 150.0g 4.25oz. Loss 15.5g 12.5g.							

Cell #2

Date	Time	Hour	B.Bent	EMF	I.R.	G.		
26.7	9.0	0	1.760	1.223	0.195			
	9.30	½	0.864	0.700	0.310			
	12.00	3	0.810	0.666	0.322			
	18.00	9	0.888	0.660	0.243			
27.7	8.00	23	0.900	0.588	0.135			
	12.00	27	0.900	0.588	0.120			
	18.00	33	0.920	0.540	0.086			
28.7	8.00	47	0.848	0.522	0.115			
	18.00	57	0.752	0.499	0.064			
30.7	8.00	95	0.732	0.468	0.129			
	The weight of the zinc after test was jointly 150.0g 4.25oz. Loss 16.5g 13.5g.							

Wednesday 25th July

38

Received 40 packets of Fitch's "perfect" battery excitants, and 8 carbon plates.

Made up 2 cells according to his directions as follows:—

In each cell 23 × 15 × 20 cms deep, 4 carbons each 23 × 15 × 1.3 cm and 3 blocks amalgamated Zinc 19 × 16 × 0.6 cm clamped together and separated by 0.8 of wooden blocks. The weight of the zinc in cell no 1. was 154.65 oz = 4380 grammes. That in cell no 2 150.25 oz = 4400 . The height of the solution was about 17 cms and 1 gallon in volume = 3780 c.c. absorbing 8 packets of excitant. The active surface of zinc is about 1350 sq. cms.

These cells were set to work at 8.30 on 0.5 ω platinoid.

A preliminary experiment was made with a frog to ascertain the sensibility of the muscular nervous tissue to the direct current. The result was that 20 microamperes was the smallest current that appreciably affects the limb 2 volt the limb and 100,000 ω in closing the circuit. This result having to be regarded as only preliminary.

Mr Edison respiration, sitting in chair thinking and speaking 16. 27. 7. 85 about 40 per min.

Thursday 26th July.

Received Condenser of 4 capacity from Mr W Marshall to test. With following results.

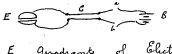
Plans of Marshall Condenser compared with Elliotts

1	2	3	4	5	6	7	8	9	10	11	12	Marshall
0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	1·0	2·0	

1	2	3	4	5	6	7	8	9	10	11	12	Elliott
0·001	0·002	0·002	0·005	0·01	0·01	0·02	0·05	0·1	0·1	0·2	0·5	

Comparison by Sir W. Thomson method using bridge + std. labile astatic galvo:

No. of Readings	Marshall plates	Pot.	Elliott plates as standard	Pot.	Balance in bridge	Ratio	Value	Discrepancy %	
(1)	1 to 10	1·0	1 to 12	1·0	2007.5	1·0037.5	1·0037.5	0·375	
(2)	11	1·0	-	1·0	2005.	1·0025	1·0025	0·25	
(3)	12	2·0	-	1·0	3995	1·9975	1·9975	0·25	
(4)	1 to 5	0·5	1 to 11	0·5	2007	1·0035	0·5017	0·35	
(5)	1 to 5	0·5	12	0·5	2005	1·0025	0·5012	0·25	
(6)	6 to 10	0·5	12	0·5	2006	1·0030	0·5015	0·30	
(7)	1	0·1	1 to 8	0·1	19964	0·9982	0·0998	0·18	
(8)	1	0·1	9	0·1	1997	0·9985	0·0999	0·15	
(9)	1	0·1	10	0·1	1993	0·9965	0·0997	0·35	
(10)	2	0·1	9	0·1	1996	0·9980	0·0998	0·20	
(11)	3	0·1	9	0·1	1997	0·9985	0·0999	0·15	
(12)	4	0·1	9	0·1	1993	0·9965	0·0997	0·35	
(13)	5	0·1	9	0·1	2003	1·0015	0·10015	0·15	
(14)	6	0·1	9	0·1	1993	0·9965	0·09965	0·35	
(15)	7	0·1	9	0·1	2003	1·0015	0·10015	0·15	
(16)	8	0·1	9	0·1	1991	0·9955	0·09955	0·45	
(17)	9	0·1	9	0·1	1990	0·9950	0·09950	0·50	
(18)	10	0·1	9	0·1	2000	1·0000	0·1000	0·00	
			Sum 4·04				0·9982		



E Quadrant of Electrometer
C Condenser with armatures joined to same
B 5 Gravity cells
a and b wire contacts pulled asunder at 60" electrification: No grounding on electrometer or condenser.

Loss of Charge test quadrant Electrometer 5 Gravity cells. all capacity 4 ↑.
Charged for 60 secs. at 16.12'

16.13.	Disconnected	Full potential	305.7
.14	after 1'	—	304.
.15	- 2'	—	303.
.16	- 3'	—	302
.17	- 4'	—	301
.18	- 5'	—	300
17.13	- 60'	—	274

Loss of charge after 5' = 5.7 = 1.9 %.

Same test of Elliott condenser. 1'

17.31	Charged.		
.32	Disconnected	Full potential	306.5
.37	after 5'	—	297.5
18.17	Loss of charge after 5'	= 7.0 =	2.3 %.
	after 45'	—	268

Insulation of 4 ↑ condenser =

$$\frac{2.06 \times 60}{4 \times \log \frac{306.7}{274}} = \frac{156.36}{4 \log 1.1192} = \frac{156.36}{4 \times 0.0475085} = \frac{1583.6}{.190034}$$

$$\frac{15.636 \times 10^{3}}{1.90034} = 8228\ \Omega.$$

Time of fall to half charge $= \frac{0.30103 \times 60}{0.0475085} = \frac{180.618}{4.7585} = 380'$

Insulation of 1 ↑ Condenser =

$$\frac{2.06 \times 145}{4 \times \log \frac{306.5}{268}} = \frac{6.5187 \times 145}{\log 1.1362} = \frac{293.17}{0.055454278} = \frac{29317}{5.54255} = 5286$$

Time of fall to half charge $= \frac{0.30103 \times 145}{0.055454} = 2444'$

The same precautions were not used to thoroughly clean the Elliott Condenser, as were taken with the Marshall Condenser

1 b.b. 0·54 = 109·7
109·3
109·8
109·0
109·45 @ 23.8° C.

After Observations

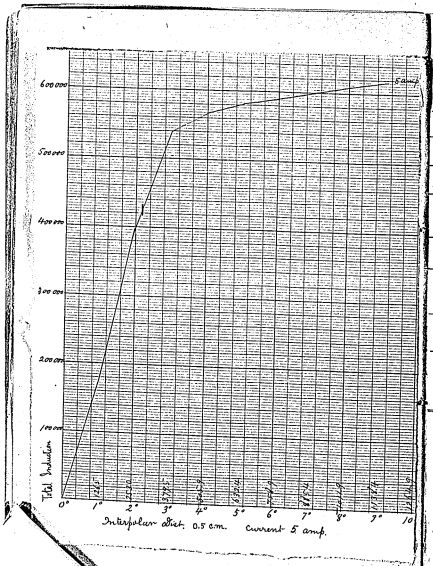
109·5
109·4
109·4
109·43 @ 27.1° C

Mean = 109·44

Rec: of Nbrick of magnet 2·509
" S " " 2·4155
Sum 4·9644

$$D = \frac{d \times 0{\cdot}7132 \times 5330 \times 10^2}{109{\cdot}44 \times 46{\cdot}57} = 74{\cdot}594\,d.$$

Time	Volts	25th Phase	Inst. b	1885 Phase	Phase	Correction	Mean Adjusted	δ	401 Y.P.
10.35	115·9		0·1		12·5	12·5	12·8	95·5	
·39	116·1		0·1		13·0	13·1			0·5
·43	116·3		0·2		22·0	22·0			
·47	116·7		"		21·0	21·0	21·3	159·9	
·49	116·9		"		20·5	20·5			
·53	116·3		0·4		44·9	44·9	44·55	332·3	
·56	116·1		0·4		44·3	44·3			
11.04	115·9		7°·45'		95·5	95·9	95·65	713·5	
·06	116·5		7°·45'		95	95·4			
·10	115·9		11°·25'		124·4	124·4	123·75	923·1	
·14	115·7		11°·25'		123·0	123·1			
·17	115·		15°·15'		143	143·4	143·15	1067·8	
·20	116·4		15°·15'		142·5	142·9			
·27	116·2		18°·45'		153·	154·3	153·7	1146·5	
·30	116·0		18°·55'		152·8	153·1			
·35	113·		22°·10'		158·5	160·4	159·55	1190·0	
·40	115·		22°·20'		159·0	158·7			
·45	114·5		28°·40'		166·	166·0	165·85	1237·0	
·50	115·1		28°·45'		165·8	165·5			
13.25	115·8		34°·30'		173·8	173·6	173·25	1292·3	
·30	116·5		34°·25'		173	172·9			
·34									0·23
·37	113·2		39°·20'		177·0	177·0	176·65	1317·7	
·42	114·5		39°·20'		176·0	176·0			
·49	114·7		39°·20'		176·3	176·3			
·54	115·3		43°·45'		180·4	180·4	180·45	1346·0	
·56	114·9		43°·40'		180·5	180·5			
14·01	113·8		47°·35'		184·2	184·2	184·1	1373·2	
·05	113·4		47°·30'		184·0	184·0			
·08	113·5		51°·30'		187	186·8	187·05	1395·2	
·11	113·4		55°·45'		187·3	187·3			
·15	113·2		53°·30'		189·0	189·0	189·1	1410·6	
·19	113·3		54°·55'		189·2	189·2			
·20									Base Adj
·22		Current	off						



Amplitude series of Magnetic Induction

(12)

Time	Volts	Amplitude Turns	Amplitude Gauss	Field Gauss	Relative Magnetic Gauss	Adjusted Mean	Magnetic Fl	Total Fl	Angle ÷ 12
									0.42
14.36	113.4		34°.26′	51	51	51.2	381g	177,890	1°
.40	113.8		34°.26′	51.4	51.4				
				113.5	113.5				
.47	113.8		"	114.	115.0	114.25	8522	396,940	2°
.50	114.0		"						
.53	113.9		"	155.5	155.5	155.25	11,581	539,310	3°
.55	113.8		"	155.	155.				
.58	114.9		34°.23′	166	163.97	163.5	12,196	567,900	4°
15.05	113.8		34°.18′	163	163.03				
.07	113.8		34°.15″	166	166.09				
.10	113.8		34°.20′	168	168.03	167.49	12,494	581,810	5°
.13	113.0		34°.25″	168	168.38				
.16	113.6		34°.20′	169.5	169.5	170.29	12,703	591,530	6°
.19	113.5		"	171.0	171.0				
.22	111.5		34°.5′	173.5	173.34				
.26	112.2		34°.10′	171.5	171.67	172.5	12,867	599,180	7°
.29	112.5		34°.15′	172	172.09				
.34	109.9		32°.24′	175	175.014	175.29	13076	608,950	8°
.37	103.1		34°.26′	175.5	175.512				
.40	113.2		34°.20′	177	177.04	177.61	13248	616,920	9°
.43	112.8		34°.10′	178	178.18				

The area swept out is

$$\frac{\varphi^\circ}{360^\circ}\left\{\pi\left(124.5^2 - 90.05^2\right)\right\} = \frac{\varphi\pi}{360}\left\{15500.3 - 8253.7\right\}$$

$$\frac{\varphi\pi}{360}\left\{7246.6\right\} = \frac{22766}{360}\varphi = 63.24\varphi$$

Barometer and attached thermometer daily readings at Noon (Aug)

Date	Inches	cms.	Temp.	Weather	Clouds	
27. 7. 88	29.929		79°	Rain	Nimbus.	
31. 7. 88	29.882		75°	Fine	Cirro Cumul	
1. 8. 88	29.882		77½	Variable	Cirrus & Nimb	
2. 8. 88	29.952	76.07	75°	Fine	Cloudy.	
3. 8. 88	29.924	76.03	76°	Fine	Heavy clouds	
4. 8. 88	29.766	75.62	81°	"	" cumulus	
6. 8. 88	29.794	75.67	79°	Cloudy +	Nimbus	
7. 8. 88	29.402	74.68	75°	Clearing	Nimbus.	
8. 8. 88	29.440	74.78	75°	"	"	

The accompanying curves shew the behaviour of 10 Grove cells arranged to work through the same external res. only differing in the quality of their zinc in which the proportion of mercury varied from 5 up to 14 %.

The weight of the zincs before and after the test were as follows grammes.

No.	5	6	7	8	9	10	11	12	13	14
Before	373.2	379.2	381.5	378	385	383.4	388	389.5	393.5	393.2
After	295.5	299.2	301.1	297.9	307.5	298.9	306.9	307.9	307.2	308.7
Loss	77.7	80.0	80.8	80.1	77.5	84.5	81.1	81.6	86.3	84.5
Order	2	3	6	4	1	8	7	5	10	9

Showing that those cells which had done the most work (namely 5 6 + 7 had consumed less zinc than the others.

Another set of zincs was placed in the battery solution so as to give no current but to allow local and chemical action to take place with following result. The test lasted from 11.20 to 14.30 and the vessel containing them became very hot

No.	5	6	7	8	9	10	11	12	13	14
Before Quiet	380.7	375.5	392.2	386.9	385.2	389.9	396.2	393.7	390.5	390.5
After Quiet	369.7	356.7	370.5	374.5	375	379.9	389.4	387	384.2	390.4
Loss	21.0	18.8	11.7	12.4	10.2	9.0	6.8	6.7	6.3	0.1
Order	10	9	7	8	6	5	4	3	2	1

Saturday 28th July.

Tested the accuracy of the barometer scale with the cathetometer as follows—

Common mark in centre of Barometer read by both telescopes

		Upper	649.32
			649.33
		Mean	649.325
By upper	64.9325		
" lower	60.4005	Lower	60.4008
			60.4009
		Mean	60.4005
Reduction of upper to lower reading	4.524		

Reading of bore point in well with lower telescope 22.3410
22.3411
22.3405
Reduction to upper telescope 4.524
26.8645

Reading of 71 Mark	97.868 − 26.8645	=	71.0035
72 "	98.870	=	72.0055
73 "	99.869	=	73.0045
74 "	100.8685	=	74.0020
75 "	101.869	=	75.0045
76 "	102.871	=	76.0085
77 "	103.870	=	77.0055
78 "	104.869	=	78.0045
			8) 39.5
	Mean Diff.		0.0049

So that the mean reading of the barometer is greater than the cathetometer distance by 0.0048 cms = $\frac{1}{50}$th of millimetre @ 75°F = 23°C

The glass cylinder case of the standard Electrometer was carefully washed and dried but it still refuses to hold a charge

Monday 30th July.

Examined in company with Mr Worthington a multiplex scheme of telegraphy invented by Mr Rogers of Washington.

Two large heavy flywheels about 18" in diam: carry eleven sectors mounted on a concentric inner circle. These sectors are maintained in communication through brushes and the line wire. The synchronism is maintained by the current sent at every revolution through the 11th sector which passes on to an induction coil & causes a spark to be visibly projected on the edge of the periphery of the fly wheel. If the wheels are in unison the spark will always be visible at or very near the same spot and this has to be attained by applying friction or rotating the contacts under personal supervision. The normal speed is 800 revs per min = a capability of 8000 signals per min = 133 per sec:

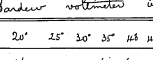
Took the highest speed attained = about 1150 revs. per min. Pointed out to the gentlemen present that though the apparatus was simple and ingenious it required continual personal supervision and that it would have to show itself superior to the Phelps printer or the Delany telegraph before it could supplant those instruments in use.

Took the following comparison of the Bardeur voltmeter with potentiometer.

Deg.	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Volts	46·1	52·1	57·0	61·0	67·0	70·8	75·6	80·4	83·6	89·6	94·6	99·0	102·4	107	110·4

Measurements and observations taken at the Exhibition ~~before~~ at the School of Mines Columbia College N.Y. before the N.Y. Board of Electrical Control.

Large black Retriever Mongrel Weight 76 lbs



Length tip to tip 65"
Dog very vicious + seemed will difficulty.
Tip nose to base tail 51"
Height 24"
Res. 15,300 Ω

14.53 First current (momentary) Volts at machine 300
Dog howled + struggled but not hurt
·57 do do Volts 400
·58 – – 500
15·02 do do amp 0·2 700
·09 do do – 0·45 – 1000
Dog violently struggling + howling at each shock but otherwise not hurt.
·25 Siemens machine excited by 100 volt Edison dynamo working into converter, volts before contact 500 by Bardeur
Contact made on dog 330. not allowing any
·10 for mean spread Dog howled while current on + struggled for a little time but then fell dead within 30 sec.
The suff. of the Loc. for Revenge of Guilty be Answered

Tuesday 30th July.

The following shews the result of a meter trial with pure zinc electrodes and pure zinc sulphate solution. Mr Sawai took the weights.

Plate No	Weight on the 29th July	Joint weight	Weight on the 30th July	Joint weight	Gain	Loss	Diff
A1	21.2342	44.0512	20.5590		0.6580	0.6752	-0.0079
C2	22.8169		23.4749				
A3	21.7793	43.7919	21.0921		0.6394	0.6872	+0.0041
C4	22.0126		22.6518				
A5	21.6737	43.3793	20.9952		0.6587	0.6755	-0.0086
C6	21.7056		22.3636				
A7	21.5789	43.6632	20.9925		0.6571	0.6864	-0.0037
C8	21.9839		22.6410				
A9	22.1016	43.0396	21.4277		0.6509	0.6739	-0.0092
C10	20.9379		21.5888				
A11	20.2062	41.4107	19.5392		0.6580	0.6670	0.0151
C12	21.2046		21.8626				
A13	20.5416	40.6726	19.8524		0.6421	0.6892	0.0061
C14	20.1312		20.7735				
A15	21.2791	42.3746	20.5948		0.6486	0.6843	0.0022
C16	21.0957		21.7643				
A17	21.5178	42.3198	20.8145		0.6627	0.7033	0.0202
C18	20.8023		21.4650				
A19	22.0525	42.1658	21.3440		0.6568	0.6885	0.0034
C20	20.1131		20.7699				
						68.205	·0288
						= 0.6821	·0036
						= 1.26%	

Tuesday 31st July

Took the sp. g. of the 4% - zinco with following result :-

		In air	In water	sp. g.
1st specimen	pure zinc	8.98	7.64	6.701
1st -	alloy	8.42	7.265	7.29
2nd -	pure zinc	12.145	10.385	6.9
2nd -	alloy	14.075	12.15	7.31

Temp: about 75°. distilled water.

$$13.6\,x + (1-x)\,6.8 = 7.3$$
$$\therefore \quad x = 7.35\% \text{ by volume}$$
$$= 13.7\% \text{ - weight.}$$

As less than 4% rather than more was expected, it is probable that the structure of the alloy does not admit of calculation in this way, the zinc appearing to be denser than in the pure crystalline state.

Wednesday 1st August.

Commenced winding a converter @ follows. ring of oxydized iron wire weighing 1.5 lbs = 24 oz = 680 grammes. #26 iron wire 0.018" covered with layer of tape. Over this the ext. diam = 8⅞". the int. diam 7⅜".

Over this #21. SWG was wound. 0.036" opened 0.03" bare

Four layers of about 581 turns each = 2905 say 2900 turns in all were layed on. the total res. being 6 ω. Above this an insulating layer of india rubber and then 13½ layers of #36 wire, 0.005" 0.122" = about 400 feet. The whole was then placed in melted paraffine wax & well taped.

Chartin
Envelope
N-880610

The opposite curve shews the exciting power necessary for different interpolar distances. And the upper ~~ex~~ curve shews roughly from that, the exciting power necessary to produce induction through the magnet at no interpolar distance or the reciprocal of the ~~conductivity~~ permeability of the iron.

Thursday 2nd August.

A set of different solutions was made up for Grenet batteries with the object of finding the best for the phonograph motor. The results are as follow.

Standard solution	5 lbs	Am. CrO_3	
# 15	15 -	Common H_2SO_4	
	40 -	H_2O	
	CrO_3	H_2SO_4	H_2O
# 16	5 lbs	20	40
# 17	5 "	25	40
# 18	7.5 "	15	40
# 19	7.5 -	20	40
# 20	7.5 -	25	40
# 21	10	20	40
# 22	10	25	40
# 23	7.5	20	40 + 3 lbs $NaNO_3$
# 24	0	15	40 + 5 lbs [illegible]
# 25	10	20	40 3 - [illegible]
# 26	7.5	15	45 5 - [illegible]

The results are shewn on the following curve sheet.

Chart in
Envelope.
N-880610

Saturday 4th August

Electrometer (abs) gave its first measurements. At a particular distance and electricity of the idiostatic gauge, the full pressure to correspond to 0.6 gr. was produced at 0.936 = 0.468 cms on the lower screw reading. The full pressure to correspond to 0.3 gr. was produced at 0.1935 = 0.7068 cms on the lower screw. This works out

$$0.468\sqrt{\frac{8\times3.1416\times0.6\times980}{3.1416\times2.25\times2.25}} = 0.468\sqrt{\frac{78.40\times0.6}{5.0625}}$$

$$0.468\sqrt{1394\times0.6} = 0.468\sqrt{836.4} = 0.468\times28.9 = 13.5$$

$$= 405.000 \text{ volts}$$

$$0.7068\sqrt{\frac{8\times3.1416\times0.3\times980}{3.1416\times2.25\times2.25}} = 0.7068\sqrt{1394\times0.3}$$

$$= 0.7068\sqrt{418.2} = 20.5\times0.7068 = 14.49$$

$$= 434.7 \text{ volts}$$

Reweighed. Electrometer spring values as follows

0.1 gramme		0.2 gramme		0.3gr	
	0.49		0.971		1.428
	.505		0.969		1.445
	.485		0.967		1.435
Mean	0.499	Mean	0.9693	Mean	1.4327

0.5 gramme		0.4 gramme		0.6gr	
	2.3334		2.863		2.710
	2.333		1.876		2.725
	2.329		1.880		2.740
					2.735
					2.726
Mean	2.332	Mean	1.873	Mean	2.7253

Temp 80°F

Diameter of disk from several measurement 4.515

check later 0.6 gramme 2.720, 2.722, 2.729 } 2.7270

a lightning flash a mile long) requires perhaps a P.D. of 10,000,000,000 volts. If so, and if the charge is resident in individual raindrops say $\frac{1}{8}$" diam, then on the supposition that the potential of evaporated steam droplets is 1000 volts a mere estimate the diameter of those droplets should be $\frac{1}{370,000}$ of an inch.

To find the rate of accumulation of potential in cloud with coalescence.

Let there be a given mass M of water in the form of very minute droplets, electrified by evaporation. Let the number (very great) of these droplets be N, their radius r and the total charge accumulated in the mass M = Q

Then $M = 4.189\, N r^3$ $\quad (\frac{4}{3}\pi = 4.189)$ $\therefore N = \frac{M}{4.189\, r^3}$

and $q = \frac{Q}{N}$ $\quad r = \sqrt[3]{\frac{M}{N}} \times \frac{1}{\sqrt[3]{4.189}}$

$\therefore v = \frac{q}{r} = \frac{Q}{Nr}$ $\quad \frac{1}{\sqrt[3]{4.189}} = \frac{1}{1.61}$

$\therefore v = \frac{Q \times 4.189\, r^2}{Mr} = 4.189 \frac{Q}{M} r^2$

or the potential increases as the square of the radius of the drops or as their surface.

also $v = \frac{Q \times 4.189\, r^2}{4.189\, N r^3} = \frac{Q}{Nr}$

$= \frac{Q \times 1.61}{N^{\frac{1}{3}} \sqrt[3]{M}} = \frac{1.61 Q}{M^{\frac{1}{3}}} \times \frac{1}{N^{\frac{1}{3}}}$

or v increases inversely as the $\frac{1}{3}$ power of N or to ~~double v~~ halving N increases v 60%, and generally diminishing N n times increases v $n^{\frac{1}{3}}$ times.

Thus if 1,000,000 droplets coalesce the potential of the resultant drop is augmented 10,000 fold:

The density or the droplet is $\frac{M}{4Nr^3} = \frac{M}{4Nr^3}$ $\therefore$ g increases as N.

		24·7			58·8
	13·7	114·41		18·2	101·1
×	16"	153·94	×	18·5	188·67
	12·5	153·93		12·5	133·72
		31·2			66

Calculation for the effect of doubling the "entrefer" in a No 20 Edison Dynamo.

At present the diam. of the iron core of the #20 armature is given as $12\frac{1}{2}$" and the diam. of the ~~inscribing~~ boring or polar extension as 14" leaving $1\frac{1}{2}$" as ~~air space~~ entrefer or 0.75" on each side. The full armature diam is given as $13\frac{7}{8}$" leaving $\frac{5}{32}$" for mechanical clearance all round. That is a winding space of $13\frac{7}{8} - 12\frac{1}{2}$ $= 1\frac{3}{16}$" $\div 2 =$ $\frac{19}{32}$ about $\frac{2}{3}$" radially. If now the entrefer were increased to $1\frac{1}{2}$" on each side the winding space would be $\frac{48-5}{32} = \frac{43}{32}$ or the radial space would be increased from $\frac{19}{32}$" to $\frac{43}{32}$" or 125% in volume. If this were obliged by wire, at least 100% gain in output would result, for the greater thickness of wire would lessen the radiation from the lower layer and prevent the full gain of 125%. The question now remains as to the restoration of the original strength of field.

The calculation given on pages 54 + 55 of Book no 3 shew that the Hopp formula applies pretty closely. By doubling the air space the voltage of the machine would be reduced in the ratio of $\frac{1.137}{2.97}$ so that the ampere turns would have to be increased 160% but the leakage would be increased enormously the polar surface would have to be abridged to begin with; and doubling the ampere turns would perhaps redeem 80% increased output.

Plating Dynamo Continued

At a velocity of 6000 ft per min or 100 per sec. = 3050 cm. per sec. and a breadth b, the area described = 3000 b, and to obtain a voltage of v volts at a field of 3000 lines per sq cm. = $\frac{v \times 10^8}{3000 \times 10^6}$ = $\frac{100v}{3}$

= 11.2v = 4.4" per volt.

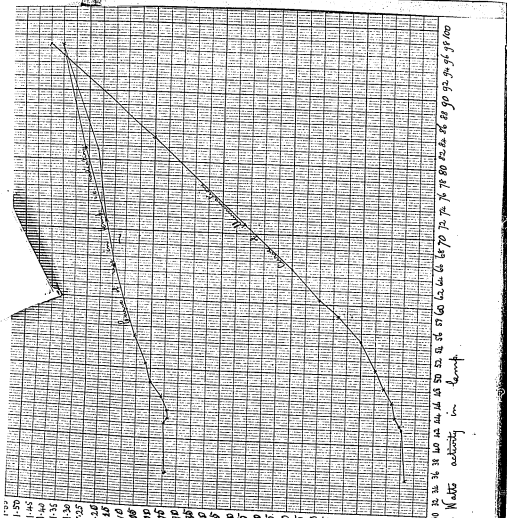
Tuesday 7th August

Completed Converter.

Took Tachograph apart and reset it again. The speed indicated by the pointer on the inside dial is about 2.03 times that of the engine flywheel.

Wednesday 8th August

Examined Westinghouse plant at Station Island. There were 3 alternating Machines (2 at work) revolving 1650 times per min with 12 Magnets radially about 10" and some 30" broad. = ~~220~~ 330 alternations per sec or 19,800 alternations per min: The indicated currents from these machines were about 47 and 57 amperes respectively at 1200 volts pressure. There were also 2 Thomson-Houston Machines one working, and 2 United States Machine 1 delivering 10 amperes at about 1900 volt pressure.



Record of Photometer test made 25th July.

(55)

Time	P.D. on side trough	P.D. on trough under test	Current thro trough under test	P.D. on resist	Temp in temp	Temp of trough outside	Watts in trough	Ratio of 1st:	B.P. of trough under test	Rise in trough F	Rise in trough C
10.38					73°F						
10.38	99.25	64.4	0.510	0.064	245°F	78°	35.2	1012.0	1.33	178°	98.5°
11.45	"	79.4	0.530	0.068	250°	83°	42.1	10.0	1.6	171°	95.0
14.55	"	79.8	0.538	0.069	254°	86°	42.9	9.0	1.778	168°	93.3
15.08	"	80.5	0.546	0.070	256°	87°	43.96	8.0	2.0	169.5	94.2
15.15	"	81.5	0.556	0.071	260	87°	46.1	7.0	2.286	173°	96.1
15.25	"	83.8	0.574	0.072	268	88°	48.1	6.0	2.667	180°	100
15.40	"	86.0	0.590	0.074	272	89°	50.7	5.0	3.20	183	101.7
15.47	"	89.0	0.614	0.077	280	90°	54.7	4.0	4.0	190	105.6
15.55	"	94.8	0.638	0.080	286	90.5	58.6	3.0	5.333	195.5	108.6
16.08	"	92.6	0.654	0.082	290	91	60.6	2.5	6.40	199	110.6
16.22	"	96.8	0.670	0.084	298	92	64.9	2.0	8.0	206	114.4
16.35	"	100.6	0.710	0.089	306	93	71.4	1.5	10.61	213	118.3
16.40	"	106.7	0.766	0.096	322	94	81.7	1.0	16.0	228	126.7
16.50	"	114.3	0.825	0.106	338	95	96.6	1.4	20.4	243	135.0

Saturday 11th August.

Required the depth of winding of 16 lbs. of # 23 BWG on the transformer core whose diam: is 6" and whose length will be 6". The diam of the wire # 23 BWG. is 0·025
Covering 0·014
0·039

The no: of turns in a layer is $\frac{6}{0{\cdot}039} = 154$.
1 lb of this wire = 528·5 ft = 6342" = 4450 ft. on 2ll.

$$l = \frac{\sqrt{36 + \frac{4 \times 6342 \times 0{\cdot}039 \times 14}{154 \times 3{\cdot}1416}} - 6}{0{\cdot}078} = \frac{\sqrt{6864} - 6}{0{\cdot}078} = \frac{2{\cdot}27}{0{\cdot}078}$$

= 29·3 say 30 @ 0·039 = 1·170"

Check on above allowing 1·27 + 6 = 7·27 as mean diam the mean circum: = 22·52" × 154 = 2472" = 290 ft nearly + 30 layers = 8700 ft.

Tried small Inductometer in Engine Room several feet from Dynamo to measure Pill.
Horizontal swing through $\frac{\pi}{2}$ Deflection on Bell gal. 56.
Vertical - - $\frac{\pi}{2}$ - - - - 28.
Throw from standard cell 0·51 - - - 123.
Diam: of wire 0·031" bare = say #14 BWG + has a res of 0·54 = 0·54 × 667·34 = 360 ft.
The external diam is 7" = 22" circum: + there are 9 turns to the layer on each reel or 18 × 22 = 396" = 33 feet so that 11 layers would be needed.

$$L_H = \frac{0{\cdot}71}{123} \times \frac{56 \times 10^{-7} \times 5{\cdot}330 \times 10^{10}}{34{\cdot}360} = \frac{7{\cdot}1 \times 5{\cdot}6 \times 5{\cdot}33 \times 10^{3}}{1{\cdot}23 \times 3{\cdot}436 \times 10^{2}} = 42{\cdot}25$$

= 21·13

L vertical

$$\sqrt{17844 + 4446} = \sqrt{2230} = 47{\cdot}2$$

Took small Grid inductor apart and examined its coils more closely to calculate its effective area. The wire is 0.083" = 0.211 cms No 14. B.W.G + its covered diam is about 0.105" = 0.267.

1) The mirror half.

Diam of channel 11.8
Diam. of fully winding 17.6 } 14.7 Mean.
Diam of 6th layer 14.9
No. of layers 11. 9 turns on top layer + 1 extra
Res. 0.265 ω @ 23°C.

If there are really 100 turns or 1500 × π cms =
$\frac{1500 \times \pi}{30.48}$ feet = 154.6 feet while the calculated length
= 0.265 × 667.3 = 176.8 feet.

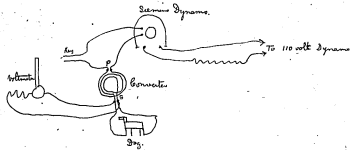
2) The back half

Diam of Channel 14.85 } 14.85 Mean
Outer Diam of winding 17.85
11 Layers 9 turns on top layer + 1 extra turn
Res 0.250 ω @ 23°C.

If there are really 100 turns or 14.85 × π cms =
$\frac{14.85 \times \pi}{30.48}$ = 153.6 feet while the calculated length
= 0.25 × 667.3 = 166.8 feet.

Res: of instrument Complete = 0.516 ω @ 75°F 23°C.

14.7 being the mean diameter of reelwinding no 1.
= 7.35 radius. = 169.72 sq. cms. × 100 = 16970 sq. cms.
14.85 being the mean diam. of reelwinding no 2
= 7.425 = 173.90 sq. cms × 100 = 17.390 sq. cms
Total area is. Plus 34360 sq. cms.



Physiological Experiment Contd.

Saturday) 11th August.

Siemens alternating Machine making 1380 revs per min = 276 alternations per sec.

Dog) ♯ 13. Black smooth terrier Weight 21½ lbs
Length 29"
Height 15"

Bandaged with wadt on opposite fore and hind legs as usual.

~~Used~~ Used large converter.

21. 13 Contact for 3 secs: in primary) Cardew voltmeter 30" = 57 × 4 = 228
− 33
195 Mean volts

Dog) quite quiet while current on and attendant did not know contact had been made, on breaking contact dog) struggled silently for a few seconds and then fell dead. The heart beat for some little time afterwards.

21. 30. Black shaggy) terrier Weight 19½ lbs
Dog ♯ 14. Length 25"
Height 14"

Used one converter. Simply the machine in ~~simple~~ circuit with dog) & voltmeter on terminal.

21. 42. Contact made for 15 secs. Cardew 70" = 98 × 2 = 196
− 20
Mean voltage 176

On breaking circuit dog) fell dead at once without any struggling. No evidence given by dog of having felt the current at all.

Dog # 15 No connector.

~~Black~~ Black beagle Weight 39 ½ lbs.
Length 26"
Height 15".

22·07 Contact made for 15 secs: Bardeen .76"
.99 × 2 = 1·98
30
178

Mean Voltage = 178

Dog gave no sign during application of current, standing rigidly like mus 13 + 14 without spasms or trembling + fell slowly on breaking circuit without uttering any sound. One or two disconnected gasps were heard, but the eyes were glassy and unresponsive, and dog evidently unconscious. Lung action quite ceased within 60 seconds.

Checked Bardeen voltmeter by lamps and also by direct current machine.

The field strength as indicated by the Grd Inductor is as follows—

Let θ be the throw from the standard cell thro 0.5 f

Then $Q = 0.5 \times 1.43 = 0.715 \times 10^{-8}$

The res: of the circuit is about 5340×10^{3}

Let the throw observed be t

Then $\frac{t \times 5.34 \times 10^{12}}{\theta} \times 7.15 \times 10^{-8}$ = Total Lines cut

or $\frac{t}{\theta}\left(\frac{5.34 \times 7.15 \times 10^{4}}{34.360 \times 10^{6}}\right) = \frac{t}{\theta}(1141)$

Chart in Envelope

Grenet Battery Trials.

The same solutions as those experimented with on the 2nd August were tried again on the 10th August, but with zinc having 10% Mercury in alloy instead of 5%.

The order of failure was (below 2 ampères)

# 22	at ½ hour	
# 15	-	9% -
# 16	-	-
# 17	-	-
# 25	-	-
# 26	-	-
# 18	-	11% -
# 19	-	11% -

leaving #s 20 and 21 still active after 12 hours

at	#20	1.950 volts	2.738 ampères
	#21	2.064 -	2.260 -

The zinc lost was as follows.

#	grammes	The previous results were grammes
15	91.8	86.5
16	85.7	83.3
17	61.8	73.2
18	121.	105.6
19	98.5	99.0
20	104.2	112
21	128.0	130
22	104	~~69.7~~ 119
25	64.9	69.7
26	77.7	101.7

Monday 13th August.

After rating watches, took them into E.R. where they have been running for 48 hours, and measured the field at a position about 130 cms. from the pole-piece on the western side of #20 machine, that is to say near its north pole.

The throws from the Erdinductor were 186, 187, 18 17

The standard coil throw 126

The Resolved throw is thus about 187.5 and the field $= 111.1 \times \frac{187.5}{126} = 165.5$ C.G.S.U. $\frac{2}{2}$ = 83

The watches were exposed to this field from 9.18 to 9.33 (15 mins). They were then placed out of magnetic range in the E.R.

Wednesday 15th August.

After rating watches, took them again into E.R. and measured the field at a position close to the N. pole of the #20 machine (on the street side of it). The throws were

horizontally 226 } Resolved = 237
vertically 65

Throw thus 0.5" 126

$$\mathcal{H} = \frac{237}{126} \times \frac{1.03 \times 10^{10} \times 7.15 \times 10^{-8}}{3.4326 \times 10^{10}} = \frac{237}{126} \times 2.14 \times 3 = \frac{1403}{2} = 200 \text{ C.G.S.}$$

Plating Dynamo. EMF 5.81 volts
P.D. at baths 2.893

Res. of baths 0.08 ω (3 in series) = 0.017 ω
Res. of leads to baths (circuit) 1.82 ω.
Res. of dynamo + leads 0.05 ω

Chart in Envelope N-880610

Copy of Mr Marshall's Lamp Data

No	Wpl	C.P.	Watts	No	Wpl	C.P.	Watts	No	Wpl	C.P.	Watts
1	7.46	7.496	55.93	29	5.83	10.644	62.27	57	4.78	14.310	68.40
2	7.39	7.602	56.19	30	5.71	10.805	62.46	58	4.75	14.448	68.63
3	7.31	7.709	56.36	31	5.74	10.928	62.73	59	4.72	14.586	68.83
4	7.24	7.816	56.59	32	5.69	11.051	62.86	60	4.69	14.725	69.06
5	7.17	7.925	56.83	33	5.65	11.175	63.16	61	4.66	14.864	69.29
6	7.10	8.033	57.04	34	5.61	11.299	63.38	62	4.63	15.004	69.47
7	7.04	8.142	57.32	35	5.57	11.424	63.65	63	4.61	15.144	69.81
8	6.97	8.253	57.52	36	5.53	11.549	63.87	64	4.58	15.285	70.01
9	6.91	8.362	57.79	37	5.48	11.675	63.97	65	4.55	15.430	70.23
10	6.84	8.473	57.97	38	5.44	11.801	64.18	66	4.53	15.57	70.53
11	6.78	8.584	58.21	39	5.41	11.928	64.55	67	4.50	15.71	70.69
12	6.72	8.696	58.44	40	5.37	12.055	64.73	68	4.47	15.86	70.89
13	6.66	8.808	58.66	41	5.33	12.184	64.91	69	4.44	16.00	71.09
14	6.60	8.921	58.88	42	5.29	12.313	65.12	70	4.42	16.14	71.34
15	6.54	9.034	59.10	43	5.25	12.442	65.32	71	4.39	16.29	71.61
16	6.49	9.149	59.38	44	5.22	12.572	65.60	72	4.37	16.43	71.80
17	6.43	9.263	59.57	45	5.18	12.702	65.78	73	4.34	16.60	72.04
18	6.38	9.379	59.84	46	5.14	12.833	65.93	74	4.32	16.73	72.27
19	6.32	9.495	60.02	47	5.11	12.964	66.24	75	4.29	16.87	72.37
20	6.27	9.611	60.26	48	5.07	13.096	66.40	76	4.27	17.02	72.68
21	6.22	9.728	60.52	49	5.04	13.229	66.67	77	4.24	17.17	72.80
22	6.16	9.845	60.66	50	5.01	13.362	66.94	78	4.22	17.32	73.09
23	6.11	9.963	60.89	51	4.97	13.496	67.08	79	4.19	17.47	73.26
24	6.06	10.082	61.09	52	4.94	13.630	67.33	80	4.17	17.62	73.48
25	6.01	10.201	61.29	53	4.91	13.765	67.59	81	4.14	17.78	73.64
26	5.97	10.321	61.60	54	4.88	13.901	67.84	82	4.12	17.93	73.83
27	5.92	10.441	61.91	55	4.84	14.036	67.93	83	4.10	18.07	74.08
28	5.87	10.562	61.98	56	4.81	14.173	68.17	84	4.08	18.22	74.37

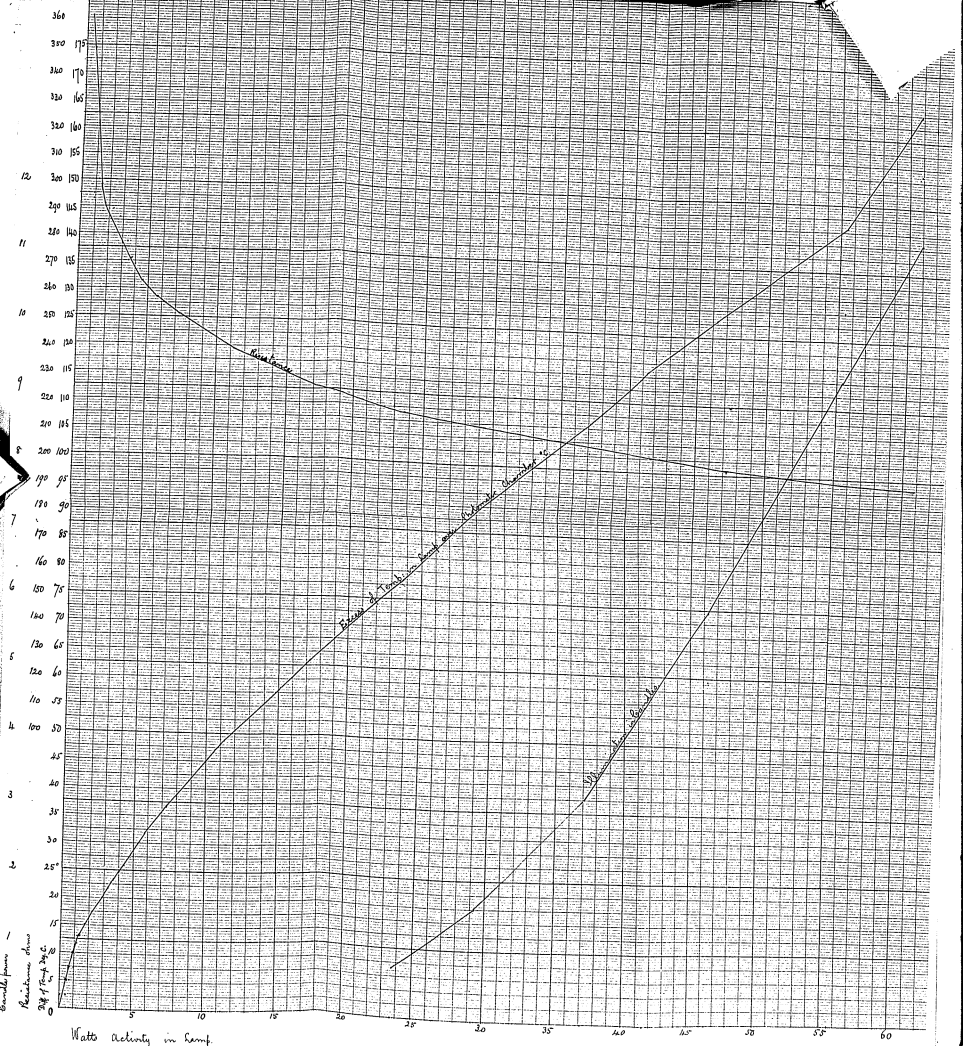
	W.p.c	B.P	Watts	No	W.p.c	B.P.	Watts	No	W.p.c	B.P.	Watts
95	4.06	18.38	74.62	115	3.49	23.22	81.03	145	3.06	25.57	87.42
96	4.04	18.53	74.86	116	3.47	23.39	81.16	146	3.04	25.75	87.40
97	4.01	18.68	74.91	117	3.45	23.56	81.28	147	3.03	25.94	87.69
98	3.99	18.84	75.17	118	3.44	23.73	81.62	148	3.02	29.13	87.97
99	3.97	18.99	75.39	119	3.42	23.90	81.73	149	3.01	29.32	88.25
100	3.95	19.15	75.66	120	3.41	24.08	82.10	150	3.00	29.51	88.53
101	3.93	19.30	75.86	121	3.39	24.25	82.20	151	2.98	29.70	88.51
102	3.91	19.46	76.09	122	3.38	24.42	82.54	152	2.97	29.89	88.77
103	3.89	19.62	76.32	123	3.36	24.60	82.65	153	2.96	30.08	89.04
104	3.87	19.78	76.55	124	3.35	24.77	82.98	154	2.95	30.27	89.30
105	3.85	19.93	76.73	125	3.33	24.95	83.08	155	2.94	30.46	89.55
106	3.83	20.09	76.95	126	3.32	25.12	83.40	156	2.93	30.65	89.80
107	3.81	20.25	77.16	127	3.30	25.30	83.49	157	2.92	30.85	90.08
108	3.79	20.41	77.35	128	3.29	25.47	83.80	158	2.91	31.04	90.33
109	3.77	20.57	77.55	129	3.27	25.65	83.88	159	2.89	31.23	90.25
110	3.75	20.73	77.74	130	3.26	25.83	84.20	160	2.88	31.43	90.32
111	3.73	20.90	77.95	131	3.24	26.01	84.27	161	2.87	31.62	90.75
112	3.71	21.06	78.12	132	3.23	26.19	84.59	162	2.86	31.82	91.01
113	3.69	21.22	78.29	133	3.21	26.37	84.64	163	2.85	32.02	91.26
114	3.68	21.38	78.68	134	3.20	26.55	84.96	164	2.84	32.21	91.48
115	3.66	21.55	78.87	135	3.18	26.73	84.99	165	2.83	32.41	91.72
116	3.64	21.71	79.02	136	3.17	26.91	85.30	166	2.82	32.61	91.96
117	3.62	21.88	79.20	137	3.16	27.09	85.60	167	2.80	32.81	91.87
118	3.60	22.04	79.34	138	3.15	27.27	85.90	168	2.79	33.01	92.10
119	3.59	22.21	79.73	139	3.13	27.46	85.94	169	2.78	33.21	92.32
120	3.57	22.38	79.89	140	3.12	27.64	86.23	170	2.77	33.41	92.54
121	3.55	22.54	80.02	141	3.11	27.82	86.51	171	2.76	33.61	92.76
122	3.53	22.71	80.17	142	3.10	28.01	86.83	172	2.75	33.81	92.97
123	3.52	22.88	80.53	143	3.08	28.19	86.83	173	2.74	34.01	93.18
124	3.50	23.05	80.67	144	3.07	28.38	87.15	174	2.73	34.21	93.39

Physiological Experiments contd.

Dog #16
Black + White Collley
Length 35"
Height 21"
Weight 57½ lbs.

21.27 After securing in box. Respiration 142 per min.
Direct Current from Municipal Machine
in direct set with dog. Voltage 400.
21.30 Contact made for 40 seconds.
Dog howled once on application of current,
consciousness ceased apparently after 15 sec.
judging by the eye. The breathing
became stertorous in a few gasps.
On breathing contact No sign of life.
Through an oversight the ammeter not read

No.	W. per B.	C. P.	Watts		No.	W. per B.	C. P.	Watts
175	2.72	34.42	93.62		191	2.45	40.99	100.43
176	2.71	34.62	93.82		192	2.40	42.33	101.59
177	2.70	34.83	94.04		193	2.35	43.91	103.19
178	2.69	35.03	94.23		194	2.30	45.30	104.19
179	2.68	35.24	94.44		195	2.25	47.16	106.31
180	2.67	35.44	94.61		196	2.20	48.82	107.40
181	2.66	35.65	94.82		197	2.15	50.76	109.13
182	2.65	35.86	95.03		198	2.10	52.73	110.73
183	2.64	36.06	95.20		199	2.05	54.99	112.73
184	2.63	36.27	95.39		200	2.00	57.00	114.00
185	2.62	36.48	95.58		201	1.95	59.92	116.84
186	2.62	36.69	96.12		202	1.90	62.57	118.92
187	2.61	36.90	96.31		203	1.85	65.60	121.36
188	2.60	37.11	96.49		204	1.80	68.39	123.10
189	2.55	38.38	97.87		205	1.75	72.80	126.18
190	2.50	39.68	99.20		206	1.70	75.61	128.52
					207	1.65	79.80	131.67
					208	1.60	84.00	134.40
					209	1.55	88.85	137.72


1
2
3
4
5
6
7
8
9
10
11
12
0
5
10
15
20
25
30
35
40
45
50
55
60
Watts activity in Comp.

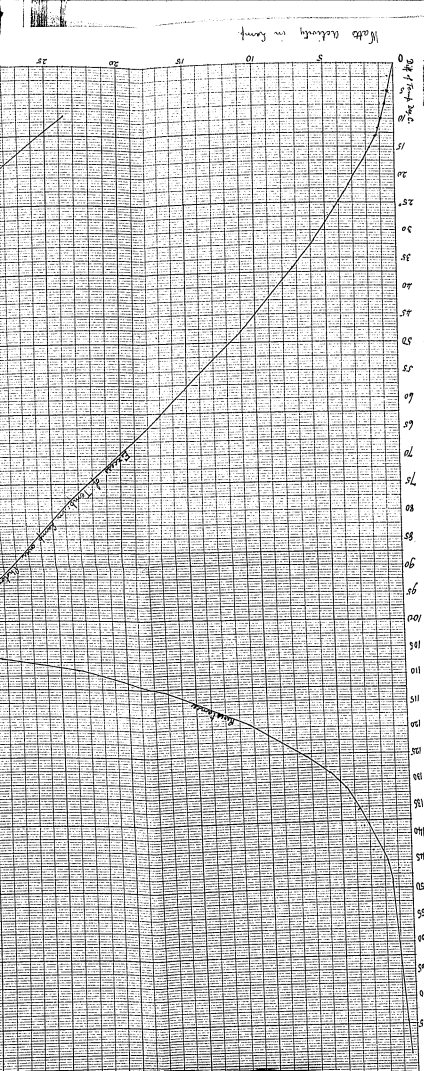
Particulars of a Tantalum Lamp. No. III. August 88

A new 16 cp lamp was fixed with the same harmometer as that used in the first trial see Books II and III, and exhausted. The vacuum was pronounced good, but the lamp failed under trial next day evidently owing to an imperfect vacuum at that time.

The standard against which its illumination was compared was a lamp given us by Mr Marshall as a Newark standard 16 cp at 101 volts. It was maintained at c.p. by the S.B. voltmeter.

Two selenium cells were placed in the photometer to ascertain if their conductivity increased with the illumination. The figures show that it did not do so to any decided extent.

The current passing through the lamp was measured by sending it also through the legal ohm whose electrodes stood in mercury cups, and measuring the P.D. between these cups by potentiometer. The P.D. on the lamp was measured by potentiometer with a reducer in the form of a bridge 100 : 9900. The Resistance of the lamp was calculated as $\frac{E}{C}$ and the activity in the lamp by E.C.



A new 16 c.p. lamp was fixed with the same thermometer as that used in the past trials see Books II and III, and exhausted. The vacuum was pronounced good, but the lamp failed under trial next day) evidently owing to an imperfect vacuum at that time.

The standard against which its illumination was compared was a lamp given us by Mr Marshall as a Newark standard 16 c.p. at 101 volts. It was maintained at c.p. by the S.B. voltmeter.

Two selenium cells were placed in the photometer to ascertain if their conductivity increased with the illumination. The figures show that it did not do so to any decided extent.

The current passing through the lamp was measured by sending it also through the legal ohm whose electrodes stood in mercury cups, and measuring the P.D. between those cups by potentiometer. The P.D. on the lamp was measured by potentiometer with a reducer in the form of a bridge 100 : 99.05.

The resistance of the lamp was calculated as $\frac{E}{C}$ and the activity in the lamp by E.C.

Time	Res. in ohms	Current in lamp	P.D. on lamp T.	Actinic Watts in lamp	Res. of lamp	Candle Power	# Reg.	Internal Temp. °C	External Temp. °C	Diff. of temp. °C	Res. of col. cell #1	Res. of col. cell #2	Degree of Illumination	
13.20	2.960	0.036	13.0	0.47	361	—	1	24.4	22.2	2.2				
·30	2.460	0.042	15.34	0.68	349	—	2	27.7	22.7	5.0	4750	387	nil.	
·40	1.960	0.058	17.0	0.99	293	—	3	30.0	22.7	7.3	do.	do.	—	
·50	1.910	0.058	17.2	0.99	297	—	4	32.2	22.7	9.5	do	do	—	
·55	1.760	0.062	18.6	1.15	300	—	5	33.3	22.7	10.6	-	-	Faint glow just visible	
14.05	1.660	0.066	19.6	1.29	297	—	6	34.4	22.7	11.7	-	-		
·15	1.460	0.077	22.4	1.73	291	—	7	35.7	22.7	13.0	-	-	dull red	
·25	1.310	0.096	24.8	2.13	289	—	8	37.7	22.7	15.0	-	-		
·35	1.160	0.100	28.6	2.86	286	—	9	40.0	22.7	17.3	-	-		
·45	1.110	0.110	30.0	3.30	277	—	10	42.7	22.7	20.0	-	-	-	
·55	1.080	0.114	30.8	3.51	270	—	11	44.4	22.7	21.7	-	-	-	
15.05	·920	0.116	31.4	3.64	271	—	12	45.5	22.7	22.8	4734	384	-	
·15	·850	0.122	32.8	4.0	269	—	13	46.1	23.0	23.1	4725	-	-	
·25	·795	0.128	34.2	4.38	267	—	14	47.7	23.	24.7	-	-		
·35	·750	0.134	35.2	4.72	263	—	15	48.8	23	25.8	-	-		
·45	·610	0.150	38.6	5.79	257	—	16	51.1	23.3	27.8	-	-		
·55	·460	0.170	42.6	7.24	251	—	17	55.0	23.3	31.7	4710	383		
16.05	4.10	0.216	51.6	11.15	239	—	18	60.0	23.3	36.7	-	-	bright red.	
·15	2.85	0.276	62.4	17.22	226	—	19	72.2	23.5	48.7	-	-		
·25	2.30	0.330	71.8	23.70	218	0.73	20	87.2	23.8	63.4	-	-		
·35	1.85	0.370	79.2	29.3	214	1.6	21	102.4	24.1	78.3	4698	..	glowing	
·45	1.00	0.424	87.4	37.05	206	3.2	22	116.6	24.4	92.2	4694	-		
·55	.86	0.450	92.2	41.5	205	4.57	23	133.3	25.0	108.3	-			
17.05	.71	0.480	96.6	46.37	201	5.93	24	143.3	25.0	118.3	-			
·15	.52	0.530	105.0	55.65	198	9.41	25	153.3	25.3	128.0	-			
·25	.42	0.556	109.6	60.92	197	11.43	26	171.1	25.5	145.6	-			
·35		0.606	120.	at this point		Candle		193.3	26.1	167.2	4705			
·45		lamp broke with pointed end, and				power suddenly fell. was soon afterwards the								
						every appearance of failure in vacuum.								

Thursday 16th August.

The weight of 1000 cm. of oxydized iron wire is on the average from 3 April 114.814 gms. The mean diam. of the wire being .0198"

∴ The winding wire is 254.47 = 176.71 sq in.
= 77.76 sq in.
= 388.8 c.in.

$.0198^2 = (1.98 \times 10^{-2})^2 = 3.92 \times 10^{-4}$

∴ the length of wire is $\frac{388.8}{3.92 \times 10^{-4}} = 99.2 \times 10^4$ "

$= 8.275 \times 10^4 = 82,750$ feet $= 252.1 \times 10^4$ cm.

$= \frac{2521 \times 114.84}{453.6} = 82.40$ lbs.

Measured the diameter of certain wire for heating.

1	Platinum	0.0041"	15	Steel	0.0152"
3	Gold	0.0172"	17	Brass	0.0158"
5		0.0152"	19	Iron	0.0172"
7	Aluminium	0.0152"	21	German Silver	0.0172
9	Magnesium	0.0172"	23	Solder	0.0420"
11	Cadmium	0.0208"	25	Copper	0.0152"
13	Tin	0.0172"	27	Lead	0.0240"
			29	Nickel	0.0126"

Magnifying power of 4" equatorial by ~~estimation~~
20.8.98 from lunar observations
50 diameters.
Small star finder 12 diameters.

Thursday) 17th August.

Measured the field of the #20 Dynamo in the space between the pole cores close above the brass grating. A frame of insulated copper wire about 10·25 × 36·8 cm embracing surface 377 sq. cms. was rotated through it. The observed throw was 14·0·5 that from 7.15×10^{-5} through the galv. 120.

$$b = \frac{14 \cdot 0 \cdot 5}{120}\left(\frac{5 \cdot 324 \times 7 \cdot 15 \times 10^{-5}}{3 \cdot 77 \times 10^{2}}\right) = 10 \cdot 13 \times 10^{-4} \times 1 \cdot 17$$

$$= \frac{1 \cdot 185}{2} \times 10^{-4} = 590 \text{ CGS U.}$$

Physiological Experiments. cont.

Yellow Mongrel — Weight 18½ lbs.
Length 24 inches
Height 14

Bandage on opposite corner leg as usual. Arranged to connect in direct circuit with 3 wire system mains. Could not detect respirations by sight.

21.17 Current on (220 volts.) barely

$47 = 72 \cdot 5 \times 3 = 217 \cdot 5$ volts. Contact maintained for 60 second. Amperes 0·2 steady. Dog howled + struggled violently in great pain. On breaking circuit not much hurt apparently. Could stand and walk.

21.33 Arranged alternating current machine volts $78 \times 2 = 156 - 15 \cdot 6 = 140 \cdot 4$ volts (mean) Current applied steadily for 15 secs. The dog never howled even on applying current. Unconsciousness ensued in 30 seconds and dog was quite dead when current removed. Should wait 1½ hrs.

Friday 18th August.

Mr Ward brought an assortment of watch hair springs which he tested before us as follows.

5 Hair springs were selected for heating in Trial Number 1.

These were

(1) Waltham. steel 0.0083 × 0.0032.
(2) Dufaux & Lutz steel best quality 0.0092 × 0.0032
(3) Howard steel
(4) Paillard palladium 0.0082 × 0.0032
(5) Elgin steel (with brass collett) 0.0102 × 0.0029

These were arranged on the end of an iron spatula as shown, and the spatula was then heated by a spirit lamp flame from beneath, at 16.02

at 16.03 The waltham spring was seen to distend and was removed while the palladium spring took its place. At 16.04½ a slight distension was observed in the Howard spring which was then removed and the springs were then as follows

At 16.09 a slight deformation in the plane of the Elgin was observed.

16.11 Heated edge of spring to redness. Slight deformation of outer coil in each case.

The springs were now cooled and examined.

(1) The best was the Paillard palladium which was very slightly deformed on outside turn but all other coils and planes perfect.

(2) Dufaux Lutz. Next best. Plane perfect but slight deformation in spacing at edge.

(3) Howard } both slightly deformed in plane + spire.
(4) Elgin }

(5) Waltham badly deformed in spire and slightly in plane at edge.

2nd trial. These same springs were tested for elasticity after heat.
The distension was 16 cms linearly between ends of spring held in forceps

(1) Dufaux-Lutz, distortion on two outer spires to extent of 0·3 cms

(2) Palladium, general distortion 0·4 cms.

(3) Elgin
(4) Waltham } equally distorted about 2·5 cms.
(5) Howard

3rd trial. Simple distension without heating.
The spring tried were:

(1) Dufaux-Lutz best quality
(2) Dufaux Lutz 2nd do
(3) Waltham
(4) Elgin
(5) Howard
(6) Palladium
(7) Common swiss 0·009" × 0·0025"
(8) Common swiss better quality 0·009" × 0·0022"

16 cms linear extension.

(1) Dufaux-Lutz 2nd quality came out but one trial, no visible distortion
0·009" def × 0·0032"

(2) } Dufaux-Lutz 1st Quality one trial
(3) } and Pallard Palladium 7 trials came out equally well.
Slight distortion of Duf. L.

Pallard (1) Slight distortion on outside spire
(2) - - - -
0·0084" (3) - - - two do do.
(4) - - - barely noticeable outside do
(5) - - - - -
(6) No visible distortion
(7) Slight distortion barely noticeable do L.

(4) } Howard on single trial and
(5) } Elgin on four trials came out about equal

Howard distorted (by dishing)		0·3 cms.
Elgin #1		0·6 "
Elgin #2	None visible	0·0 "
Elgin #3		0·5 "
Elgin #4	None visible	0·0 "

(6) Waltham on single trial distorted 0·7 cms dishing on 5 or 6 outside spire

(7) 2nd quality (better) of Common ~~stel~~ swiss spring

#1.	distorted (by dishing)	1·2 cms
#2	" " "	2·5

(8) 1st quality common of common steel swiss spring
~~Best~~ trial distorted (by dishing) 3·6 cms
2nd " " " " 0·5 "

Heat Test 4th trial.

A Bunsen Burner was first tried as the source of heat but autosegnually as this was too slow, a blowpipe & bellows were substituted which brought springs on copper spatulas to redness in a few seconds.

(1) The best was the Elgin very slight distortion
(2) Next was the Howard
(3) Pollard
(4) } Waltham } about equal distortion.
(5) } Ruty }

The other springs tried broke before fair comparison made.

Sunday 19th August

Ascended hill with 2 aneroids to ascertain height of summit

height of summit		(1) Kew	(2) Barnetts	Difference (1-2)	Elevation (1-2)	Dip	Ref.
14·15	Left residence	30·024	29·61	0	0		
·37	Reached Summit	29·605	29·12	375	460		
15·25	Left Summit	29·600	28·96	380	410		
·29	Below Cliff.	29·680	29·00	310	400		
·15	Level of Queen's Hotel	29·824	29·300	105	105		
·58	Queen Laboratory	30·033	29·41	0	0.		

The weight of the indications of (1) are say 3 times as great as that of (2) so that mean elevation of summit = $\frac{1140 + 410}{4} = \frac{1550}{4} = 390$ feet.

Point reached bore just N.W. of St Johns R.C. Church spire or N. 76° W. Map from Laboratory < between Lady (Abbey Green) + St Johns Spire being 31°. 10'

Monday 20th August

11.28 Exposed watches 3 at a time to strong magnetic field between the poles of pendulum el. magnet. Current about 5 amperes. Measured field by means of a small spool of wire, whose constants are as follows.

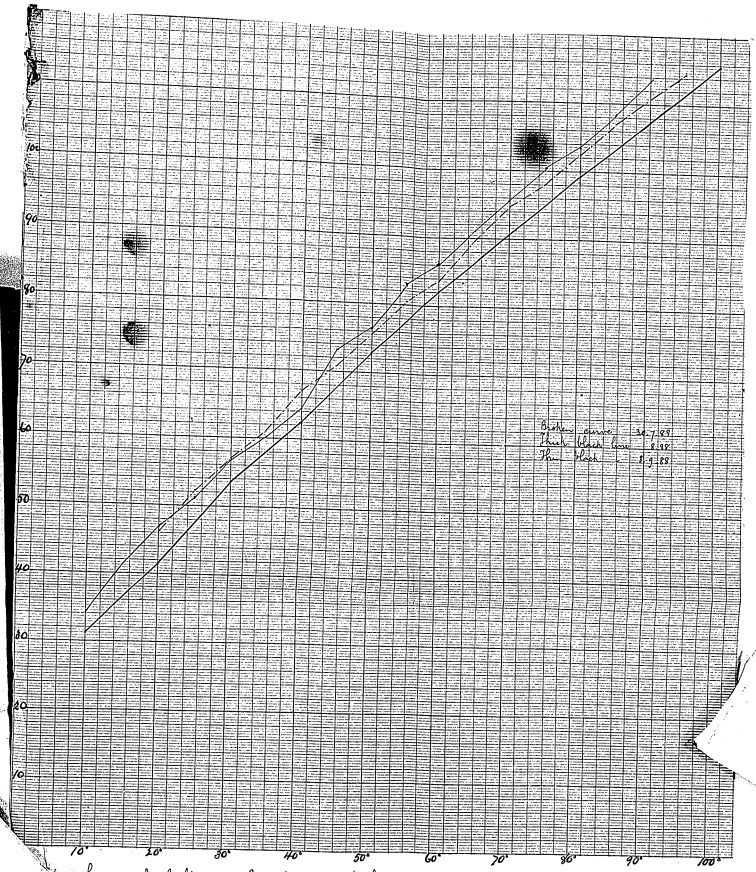
The wire diam 0.2575"
- outer - 0.5075"
- breadth 0.5

This was wound with 7 layers of silk covered wire. The 1st layer had 16 turns the 2nd 15 and all the other outer layers had 14.

The calculated total area enclosed was 78.9 sq. cms.

The throw produced by rotating this through $\frac{\pi}{2}$ was 63 divs. twice successively and the throw from the standard cell was 121 so that $h = \frac{63}{121}\left(\frac{5.316 \times 7.15 \times 10^{8}}{78.9}\right) = \frac{25\,10}{2} \text{ C.G.S.U.} = 1260 \text{ CGSU}$

All the watches stopped during the exposure to this field. They were unexposed & lay dial up.

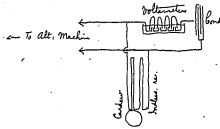


Curve of Voltmeter Readings 21st August 1888.

Tuesday, 21st August

[illegible] it in the alternating current.
[illegible]ed it in charging a small condenser
[illegible] the view of ascertaining whether any
[illegible] effect could be observed.
The mean EMF was about 110, the alternati[illegible]
[illegible] per sec: No heating effect could
[illegible] observed during half an hour, but
[illegible] experiment was made, and a
[illegible] amount of heat might have been
[illegible] without noticing it.
A larger condenser of nearly 3 [illegible] capy.
was then employed, and after removing
[illegible] at one time from the circuit, a
discharge was observed to take place on
[illegible] the terminal.
A flat irregular cake of resinous material
had 10 pairs holes pierced in it as shown
in plan. Couple 1 took the
main electrode. The other couple
took loops of different sized platinum
wire. The sizes were 0.0015" pt.
0.004" pt
0.0075 pt. iridium
0.008 pt

The free ends of the loops were connected
beneath and then all the wires beneath
were sealed up by pouring hot sealing
wax on them. Finally the loops
standing above were cut about 2 cms from



the brass thin leaving four little voltameter of plates formed by upright wire. The whole was submerged in dilute H_2SO_4 in an evaporating dish, and connected in to the Condenser circuit.

Only two of the voltameter gave any discharge. Although bubbles of gas could be detected on the surface of the other wires. The finest wire gave a splendid discharge. The next size 0.004 about half as much. The gas developed by the finest wire voltameter was observed to be 7.6 c.c. in 14 m. 0 sec. or 840 sec. the Bar. being about 29.7" and the temp 70° F. The EME during that time was observed to be $78.4 \times 2 = 156.8 \times 0.9 = 141.2$ = mean voltage

$\frac{141 \times \pi}{2} = 70.5 \times \pi = 221.5$

In 840 sec. the quantity of electricity entering the condenser would be

$2 \times 840 \times 2.94 \times 2.75 \times 10^{-7} \times 221.5$

$= 2 \times 8.4 \times 2.94 \times 2.75 \times 2.215 \times 10^{-1} = .3021$ ac.

Each C deposes 0.0001038 gm. H.

∴ the qty H. produced should be $3.021 \times 10^{-1} \times 1.038 \times 10^{-4}$
$= 3.124 \times 10^{-5} = 0.00031$ gm.

a gramme equiv 11000 c.c. so that the H developed would be $1.1 \times 10^{4} \times 3.1 \times 10^{-5} = .341$ c.c. and the mixed gas would be 68.2 c.c.

Gardner voltameter Comparison by Potentiometer.

	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
Volts	34.4	41.8	53.9	62.8	73.0	82.2	90.66	99.59	107.91	115.83

Wednesday 22nd. August.

Exposed watches at 11.0 to a very severe field. Current through large magnet about 10. amperes. (24 ohm ring 52.30) and the J.P.D. 2.1 One watch was placed in this field at a time vertically, #s 6 and 9 stopped altogether after this ordeal. The Condenser throw was 116 the throw from the field explorer 70 (mm) so that the field is

$$\frac{7.0}{116}\left(\frac{5.94 \times 7.15 \times 10^{3}}{7.9}\right) = \frac{7.0}{116}\left(4.834 \times 10^{3}\right) = 292 \times 10^{3}$$

$= 2920$ C.G.S. U.

Repeated Electrolytic alternating Experiments. Prepared two voltameters of platinum wire plates 0.001 and 0.002" diam. respectively. Length of each wire about 2 cm. Placed these in two separate evaporating dishes and placed them in series with the condenser used yesterday and whose capacity we checked as 2.957 ∎. It is marked 2.58 ∎. The gas liberated in a certain time not noted was found to be apparently equal (certainly within 5%) from both voltameters. On cutting the wire down so as to lessen the exposure, disruptive explosions accompanied by sparks occurred on making and also on breaking the condenser circuit. These ended in breaking of the plates. The indicated voltage was 8.5 volts mean.

20th August 1888

#17 Brown terrier Weight 20 lbs
Length 26"
Height 14"
Res: 8000ω
Respiration 144 per min.

Used direct continuous current
20.45 Contact 35 secs: Volts 75" × 3 =
95" × 3 = 285 – 285 × 25% Amperes 0.035.
Dog howled when current applied
set head down results could not be
seen. When current removed dog dead.
Res: after death little under 1000ω

#18 Black and tan terrier Weight 16½ lbs.
Length 27"
Height 13½"
Res. 4200ω

Dog breathing quietly Res: unable to note
21.23 Alternating current ruly 300 per
sec: Contact 2 secs.
Volts. 100" × 4 = 116 × 4 = 464 – 46 = 418 volts
Dog howled slightly on applying current
On removal of current death not
instantaneous but followed silently in
about 30 secs. Res: after death 4700ω.

Thursday 23rd August

Ran a new phono. motor @ follows.
New Grenet cell 5% Hg-Zn alloy)

Commenced trial at 17.0

Condition	Revs per min	E.	Volts	Watts
Running light	106	2.84	1.802	5.12
Spectacle down	100	2.84	1.742	4.95
Running off ½"	96	2.84	1.717	4.87
Running off 1"	92	2.84	1.607	4.56
Machine held	0	2.84	1.549	4.40.
Grenet altered				
Running light	80	2.84	1.738	4.94
Spectacle down	80	2.84	1.730	4.91
Running off 1"	80	2.84	1.719	4.88

Set machine running on a new cell, at 18.0
E. 2.84 V. 1.799.

21 o'clock E. 1.63. 1.716

The instrument was removed for one hour at 21.45 but with that exception continued running all night. Speed falling slowly. Instrument continued to run till 14.30 the last speed being 36 revs. E. 1.44.

Friday 24th August.

16.38 Set 9 meter bottle to work as follows:

		Weight	Sum
1	25.0048	48.1772	48.1756
2	23.1708		
3	25.1419	48.4910	48.4899
4	23.3480		
5	24.2415	49.0244	49.0233
6	24.7818		
7	25.0218	49.5428	49.5424
8	24.5006		
9	24.6624	49.2587	49.2574
10	24.5950		
11	24.1605	48.9504	48.9488
12	24.7080		
13	25.0602	50.1629	50.1622
14	25.1028		
15	24.1752	48.8266	48.8244
16	24.6492		
17	24.1430	47.8698	47.8688
18	23.7258		
19	24.0566	47.8118	47.8102
20	23.7536		

These plates with the exception of #20 were 1% Mercury alloy plates of pure zinc prepared by Wilmoski. The solution was that used last time. #20 was an ordinary zinc plate unamalgamated. #19 + #20 were joined up in circuit for 75 min with 2 ampères but not intended for work + thrown out.

Exposed watches right through their ~~the~~ hair spring to a powerful field produced by pointed polepieces at 2 cms. in. p. dist. The throw from 0·54 being 118. that from the field explorer for $\frac{\pi}{2}$ was 193 with 55° (abt 10 amps) on ring tangent. The field was thus

$$\frac{1}{2}\,\frac{193}{118}\,(4\cdot834\times10^{3}) = 3950 \text{ C.G.S.U.}$$

Saturday 25th August.

Exposed Watch #1 to a condensed powerful field maintained by about 7 amperes with the pointed poles at about 1·6 cms int. p. dist. The single throw with the field explorer was 111 that from the condenser 120·5 so that the field was. $\frac{111}{1205}(4\cdot834\times10^{3}) = 4450$ C.G.S.U. This was directed as closely as possible upon the centre of the balance wheel.

The ~~error~~ of the watch by the clock was compared by means of the chronograph and a contact breaking key from time to time but it was found that the indications thus obtained were irregular and useless owing it was supposed to the shifting of the minute hand under the attraction which visibly took place between it and the poles. Consequently a run of 11 minutes was taken and the rate during this period was carefully

compared by chronograph. It is appended and shews a gaining rate of 1·376 secs. per min.. Starting with this basis the previous observations were worked up correcting for the hand shifting as follows

No.	Clock Time	Indicated Watch Time	Corrected Watch Time (Mean Sol. Time)	Differences	Rate	Gain in that interval	Rate from interval	
1	12·00·00	12·00·11·5		+11·5				
					72			
2	11·46·7·8	11·46·00		−7·8	+1·388	19·3	+1·388	
3	11·33·26·2	11·34·00	11·33·00	−26·2	+1·392	16·14	+1·291	
					48	16·8		
4	11·20·41	11·21·00	11·20·00	−41	+1·336		+1·323	
					48			
5	10·43·33	10·38·00	10·42·00	−93	+1·367	52	+1·398	
					227			
6	9·34·127	9·32·00	9·31·00	−127	+1·401	99·7 ~~397~~	+1·438	

compared by chronograph. It is appended and shews a gaining rate of 1·376 secs per min.. Starting with this basis the previous observations were worked up correcting for the hand shifting & pillars

No.	Clock Time	Indicated Watch Time	Corrected Watch Time taking 1st Obs.	Difference	Rate	Gain in last interval	Rate during interval
1	12·00·00	12·00·11·5		+11·5			
2	11·46·78	11·46·00		−7·8	+1·388	19·3	+1·388
3	11·32·00	11·31·00	11·33·00	−21·2	+1·342	16·4	+1·291
					+1·336	16·8	+1·323
					+1·367	52.	+1·398
					+1·401	99·7	+1·438

To find the rectilinear equation of motion of a particle attracted to a centre with a force directly as the distance and retarded with a force directly as the velocity.

$r = ce^{-\rho \cot a}$ where c is a constant
r . the radius vector
a . . angle of the spiral
ρ . . . described from O.

Let $\rho = \omega t$

$x = a + r \sin\rho$

Then $x = a + c \sin\omega t \, e^{-\omega t \cot a}$

$$\frac{dx}{dt} = c\omega \cos\omega t \, e^{-\omega t \cot a} + c \sin\omega t \, e^{-\omega t \cot a}(-\omega \cot a)$$

$$= c\omega e^{-\omega t \cot a}(\cos\omega t - \sin\omega t \cot a)$$

$$\frac{d^2x}{dt^2} = c\omega e^{-\omega t \cot a}\{-\omega \cot a(\cos\omega t - \sin\omega t \cot a) - \sin\omega t(\omega) - \cos\omega t \cot a\,\omega\}$$

$$= c\omega^2 e^{-\omega t \cot a}\{-2\cot a \cos\omega t + \sin\omega t \cot^2 a - \sin\omega t\}$$

$$= c\omega^2 e^{-\omega t \cot a}\{\cot a(\cos\omega t - \sin\omega t \cot a) - \sin\omega t(\cot^2 a - 1)\}$$

$$= -2\omega \cot a \frac{dx}{dt} - \omega^2(x-a)(\cot^2 a - 1)$$

$$= -2k\frac{dx}{dt} - \frac{\omega^2}{\sin^2 a}(x-a)$$

$$= -2k\frac{dx}{dt} - \mu(x-a)$$

$$\frac{d^2x}{dt^2} + 2k\frac{dx}{dt} + \mu(x-a) = 0$$

where $2k$ is $2\omega \cot a$ = the component of retardation
and μ $\frac{\omega^2}{\sin^2 a}$ = - - - attraction.

vide C. Maxwell page 346 Vol 2 where a different solution is given.
350

Let m' be the mass of an imaginary projectile the projection of whose trajectory on the scale shall coincide with the actual movement of the spot and whose energy shall at all times be equal to the energy of the needle.

Then if ω be the ang. vel. of needle at centre of scale and of the projectile at the outset $\frac{1}{2} m r^2 \omega^2$ ~~the~~ $= \frac{1}{2} I \omega^2$. where r is the radius ~~of~~ of the projectile and I is the moment of inertia of the needle. Then $m r^2 = n r_1^2$.

or $\frac{r}{r_1} = \frac{\sqrt{n}}{\sqrt{m}}$ where n is the mass of the needle and r_1 its radius of gyration about its central stem. and $m = \frac{n r_1^2}{r^2}$

Here r is always determined by the initial impl.

Let the initial energy of the projectile be $\frac{m v^2}{2}$. Then $v = \rho \omega_1$ where ω is the ∠vel that the projectile would have if its orbit were circular but $\not\propto \omega_1 = \frac{\omega}{\sin a}$

$$\therefore v = \frac{\rho \omega}{\sin a}$$

$$\text{and } \frac{m v^2}{2} = \frac{m \rho^2 \omega^2}{2 \sin^2 a}$$

After the lapse of any time t an angle θ is generated such that $r = \rho e^{-\omega t \cot a}$ or $\rho e^{-\theta \cot a}$

At any subsequent period $\frac{m \rho^2 \omega^2 e^{-\omega t \cot a}}{2 \sin^2 a} = \frac{1}{2} I \frac{\omega^2 e^{-\omega t \cot a}}{\sin^2 a}$

$v r = \rho e^{-\omega t \cot a} = \frac{\sqrt{n}}{\sqrt{m}} \cdot \frac{r_1}{r} \cdot \rho e^{-\omega t \cot a}$ ~~more I can't prove~~ r

The energy remaining after an angle π has been described will be

$$\frac{m\rho_1^2\omega^2}{2\sin^2 a} = m\rho^2 e^{-2\pi\cot a}\frac{\omega^2}{2\sin^2 a}$$

So that the energy lost in overcoming friction is $\frac{m\rho^2\omega^2}{2\sin^2 a}\left(1-e^{-2\pi\cot a}\right)$

which will be the energy of the projectile at the outset of its second trajectory

or $\frac{m\rho^2\omega^2}{2\sin^2 a}\left(1-e^{-2\pi\cot a}\right) = \frac{m\rho_1^2\omega^2}{2\sin^2 a}$

Let $\frac{\rho}{\rho_1} = R^2$

Then $R^2 = \frac{1}{1-e^{-2\pi\cot a}}$

Since $\frac{\lambda}{\pi} = \cot a$ $= \frac{1}{1-e^{-2\lambda}}$

$$R^2(1-e^{-2\lambda}) = 1$$

$$\therefore R^2 - R^2e^{-2\lambda} = 1$$

$$e^{-2\lambda} = \frac{R^2-1}{R^2}$$

$$e^{-\lambda} = \frac{\sqrt{R^2-1}}{R}$$

$$\lambda = \log_e\frac{R}{\sqrt{R^2-1}}$$

Suppose that the elongation η is the first throw and that through the effect of damping the νth throw is $\frac{\eta}{R}$

where $R = \frac{1}{\sqrt{1-e^{-2\pi\cot a}}}$

Then $\lambda = \frac{1}{\sqrt{n}} \log_e \frac{1}{\sqrt{1-e^{-2n\cot\alpha}}} = \frac{1}{n} \log_e \sqrt{1-e^{-2n\cot\alpha}}$

but the rth throw would be after a throw of rn radians so that ρ would be

$$\rho_r = \rho e^{-rn\cot\alpha}$$

$$\therefore \quad \frac{\rho_r}{\rho} = e^{-rn\cot\alpha} = e^{-n\lambda}$$

$$\frac{\rho}{\rho_r} = e^{n\lambda} \quad \therefore \quad \lambda = \frac{1}{n} \log \frac{\rho}{\rho_r}$$

Where $R = (1 - e^{-2n\cot\alpha})^{-\frac{1}{2}}$

$\therefore \log R = -\frac{1}{2} \log (1 - e^{-2n\cot\alpha})$

$\log R^2 - 1 = +2n\cot\alpha$

$\therefore \log$

An additional method of proof.

The initial energy possessed by the projectile at the ∞ is $\frac{mv^2}{2} = \frac{mp^2\omega^2}{2\sin^2\alpha}$

The work done by the projectile against a retarding force of $2mkv$ through an indefinitely small space ds is

$$2mkvds = 2mk\frac{vrd\theta}{\sin\alpha} = \frac{2m\omega\cot\alpha\,\omega r^2 d\theta}{\sin\alpha}$$

$$= 2m\omega^2\frac{\cot\alpha}{\sin^2\alpha}r^2 d\theta \qquad \text{But } r = pe^{-\theta\cot\alpha}$$

$$\therefore r^2 = p^2 e^{-2\theta\cot\alpha}$$

$$\therefore \text{Wk} = 2m\omega^2\frac{\cot\alpha}{\sin^2\alpha}p^2\int_0^\infty e^{-2\theta\cot\alpha}d\theta = 2m\omega^2\frac{\cot\alpha}{\sin^2\alpha}p^2\left(\frac{e^{-2\cot\theta}-1}{-2\cot\alpha}\right)$$

$$\therefore = \frac{mp^2\omega^2}{\sin^2\alpha}\left(1-e^{-2\pi\cot\alpha}\right)$$

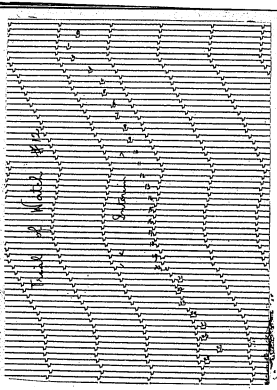
The work done upon the projectile by the attractive force μm through an indefinitely small space ds of its path is $ds\cos\alpha\,\mu m$

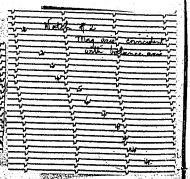
$$= \frac{m\cos\alpha}{\sin^2\alpha}\omega^2 r^2 d\theta \therefore W = m\frac{\cot\alpha}{\sin^2\alpha}\omega^2 p^2\int_0^\infty e^{-2\theta\cot\alpha}d\theta$$

$$= \frac{m\cot\alpha}{\sin^2\alpha}\omega^2 p^2\left(\frac{1-e^{-2\pi\cot\alpha}}{2\cot\alpha}\right)$$

$$= \frac{m}{2}\frac{\omega^2 p^2}{\sin^2\alpha}\left(1-e^{-2\pi\cot\alpha}\right)$$

so that the energy lost will be the difference of these quantities or $\frac{m}{2}\frac{\omega^2 p^2}{\sin^2\alpha}\left(1-e^{-2\pi\cot\alpha}\right)$



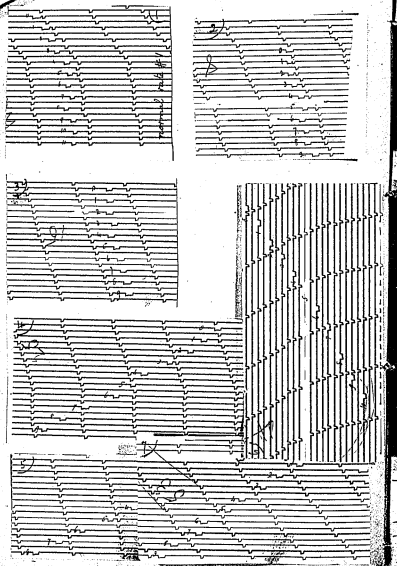


Monday 27th August

Paillard Watch #12 was placed with its dial up in a powerful magnetic field the magnetic axis coinciding practically with the balance wheel axis. A run of nine minutes failed to show any decided change in rate under these circumstances. If anything there is a losing rate. This rate amounts to 0·6 secs in 28 hours = 1·2 per hr = 29 per diem

Paillard Watch #2 was placed under the same circumstances in the same field. The rate is evidently losing about 2·2 secs in 11 mins = 12 secs per hour = 288 per diem.

In second run was with the magnetic axis eccentric to the balance wheel axis of −2·8 secs in 7 mins = ·25 secs per hour = 6·00 per diem



In the afternoon exposed Watch #3 to the field but it stopped continually.
Took the following result with #1

1st trial Watch compared with chronograph without magnetic field. Diagram #1
Gained in 11 mins 0.15 secs.
at rate of = rate of + 0.82" per hour
= - - + 19 - diem.

2nd trial In field magnetic and wheel axes almost coincident. Def. on Ring ten. 8°
Field throw 38, 35.5 Mean 36.8 = 1480 C.G.S. u.
Watch gained (Diagram #2) 13.4 secs in 9 mins
= rate of + 2.2 secs per hour
+ 52.8 secs per diem

3rd trial In field unaltered condition Def. 15°
Field throw 60.5 59.0 Mean 59.75 = 2400 C.G.S F
Watch gained 0.4 (Diagram #3) in 9 mins
= rate of + 2.67 secs. per hour
+ 64 secs. per diem

4th trial Def. 25° Field throw 89 86 86 Mean 87
= 3500 C.G.S. Field.
Watch gained 3.9 secs (Diagram #4) in 9 mins.
= rate + 26 secs. per hours
+ 624 - - diem.

5th trial Def. 35.15 to 36.15° Field throw 105 107 Mean 107.5
= 4300 C.G.S Field.
Watch gained (Diagram #5) 16.1 secs in 8 mins.
= rate + 20.75 secs. per hour.
+ 738 - - - diem.

Omit 6th trial Def. 46° Field throw 118 120 118 Mean 118.3
= 4790 C.G.S Field. (Diagram #6) N.B. This was first trial in order and results were afterwards omitted
Watch gained 4.6 secs in 10 mins
= rate of + 27.6 secs per hour.

7th trial Def. 53 to 53.5° Field throw 123, 122 123 Mean 122.5
= 4930 C.G.S Field (Diagram #7)
Watch gained 4.35 sec in 7 mins = 37 secs per hr = 696 secs per diem

Monday 27th August
Physiological Experiment

#19 Yellow spitzbergen dog. Weight 37½
Length 32
Height 18
Res: 200,000 ω
wetted bandages thoroughly) and repeated
test. resistance still as high.
Resp: invisible.

20.48 Continuous Current
Cardew voltmeter 52° = 76° × 4 = 304 volt
Contact for 30 secs:
On making contact dog leaped from box.
Howled and struggled almost all time.
After current dog not apparently hurt.
Resp: slow but not measurable.
Res: after shock 40,000 ω.

21.15 Cardew Voltmeter 95°.
Alternating Current direct from machine
= 110 × 0.9 = 100 volt.
Contact for 65 second. Dog silent
when current put on but howled
once at about half period.
Dog apparently considerably depressed but
not seriously hurt.

30 Cardew voltmeter 57° = 80 × 7 = 560 × 0.90
Contact for 30 second. During that
time the dog was silent and moaned
the head and body slowly falling. No struggle.
Dog dead when current removed. Res: after death 4000

Chart in
Envelope
N-880610

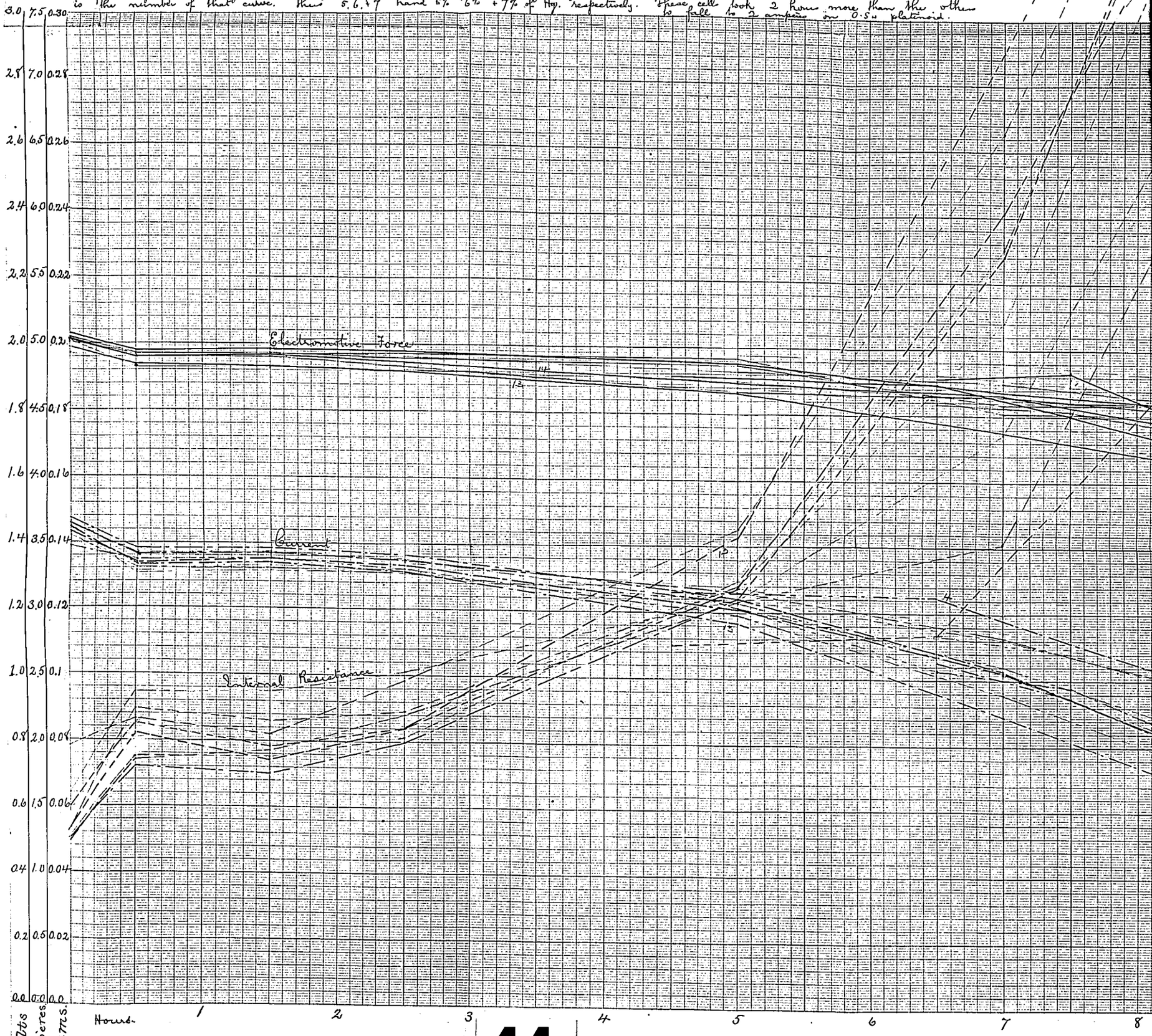
120 2nd Dog Small brown ~~wh~~ mongrel.

Weight 12½
Length about 17
Height about 10.
Resistance 1000
∴ Resp: could not be detected

22.00
Alternating Current without converter
usual speed of reversal (300 per sec).
Voltmeter 62° = 85° × 7 = 595 × 9 = 535.5 volts
Contact 1½ secs: as closely as could be judged
Dog uttered no sound. Ammeter about 0.38
(not reliable) After current removed gave
few convulsive gasps and died very quickly
Res: after death 26.00

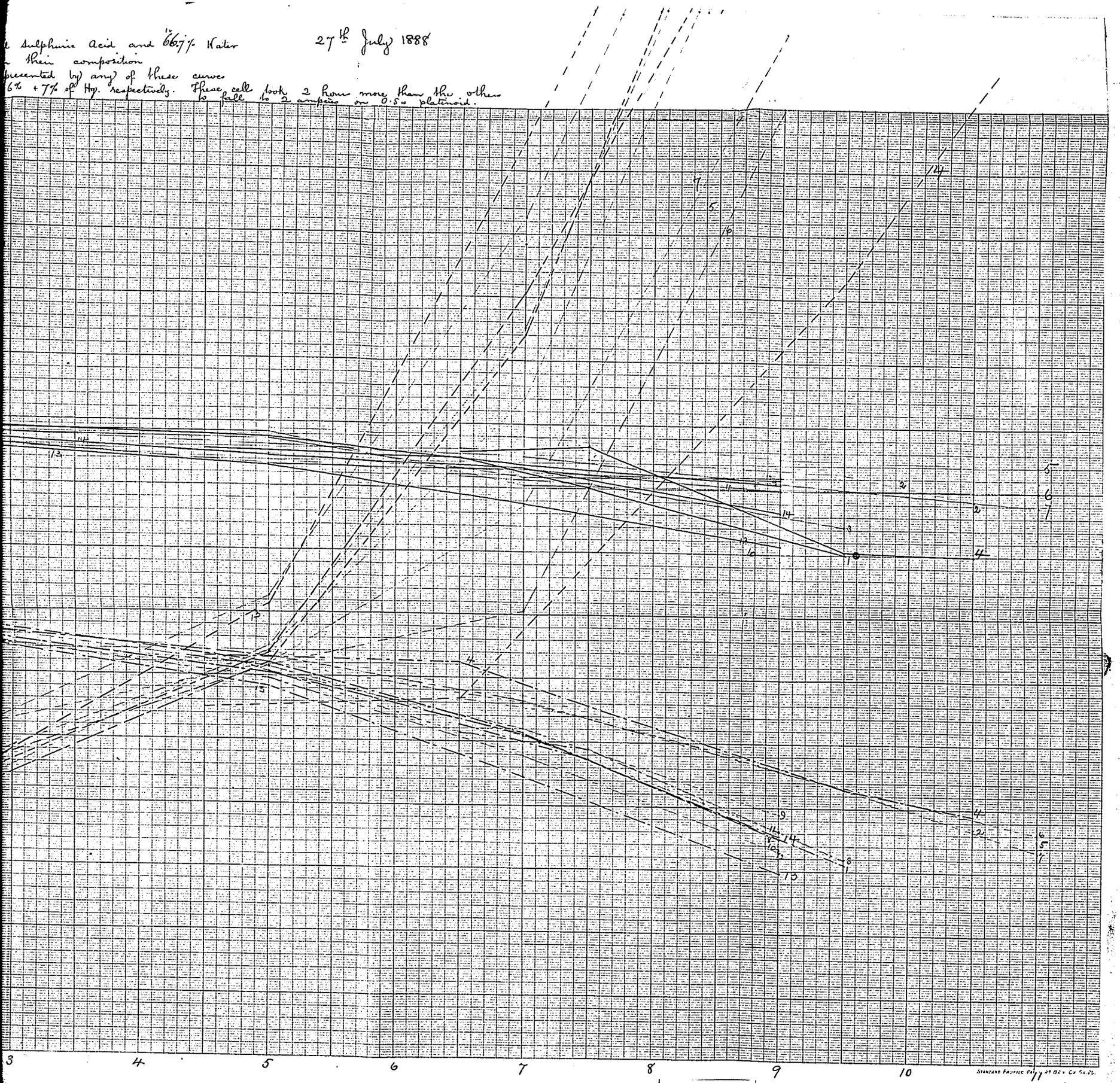
Curves of 10 Grenet cells set up with same solution
viz 8.33 % American Chromic acid, 25.0 % Commercial Sulphuric Acid and 66.7 % Water
but with zincs made up with varying % of Mercury in their composition
The percentage of mercury in the zinc of the cell represented by any of these curves
is the number of that curve. Thus 5, 6, + 7 hand 5% 6% + 7% of Hg. respectively. These cells took 2 hours more than the others
to fall to 2 amperes on 0.5 ω platinoid.

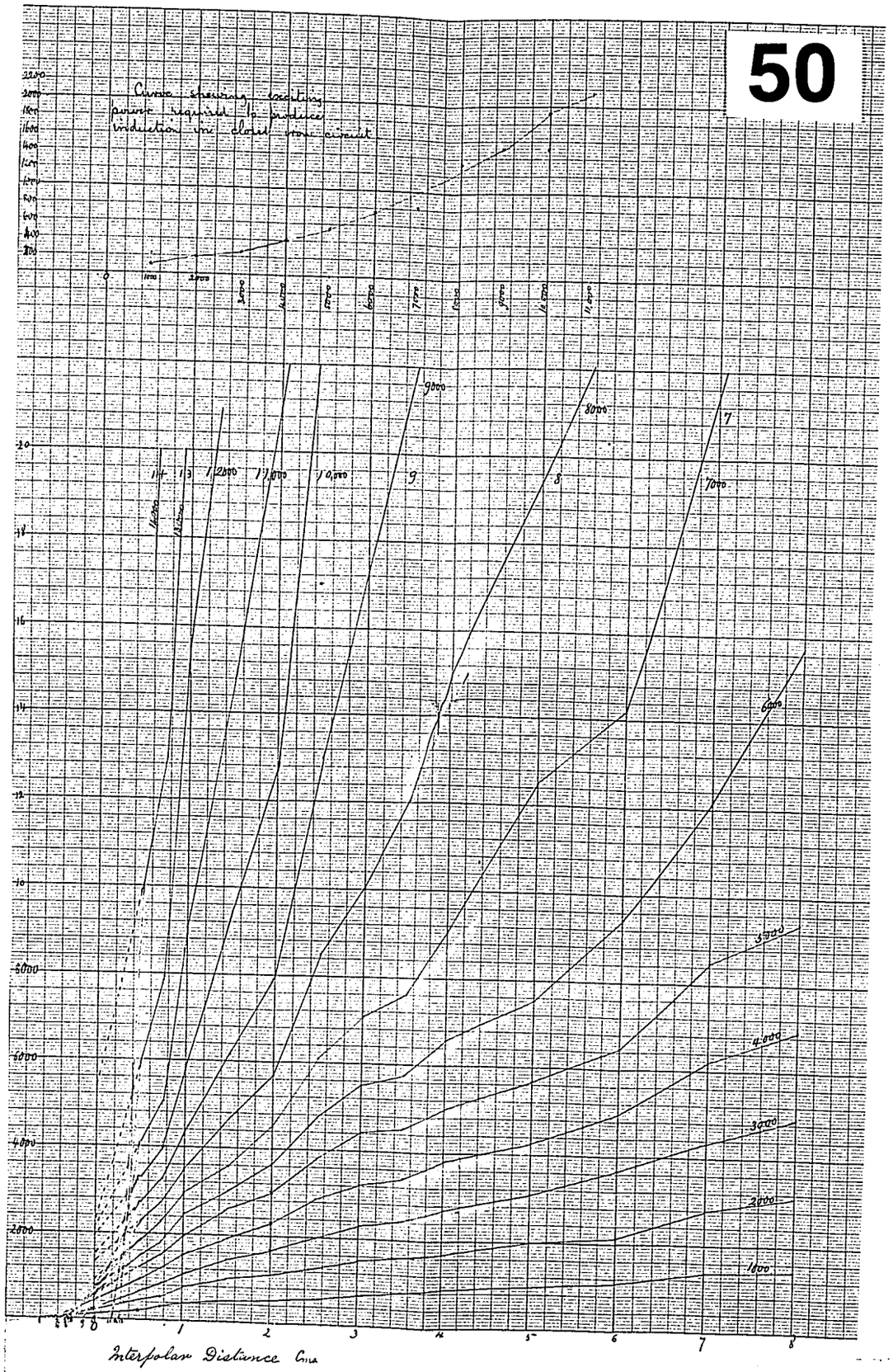
27th July 1888

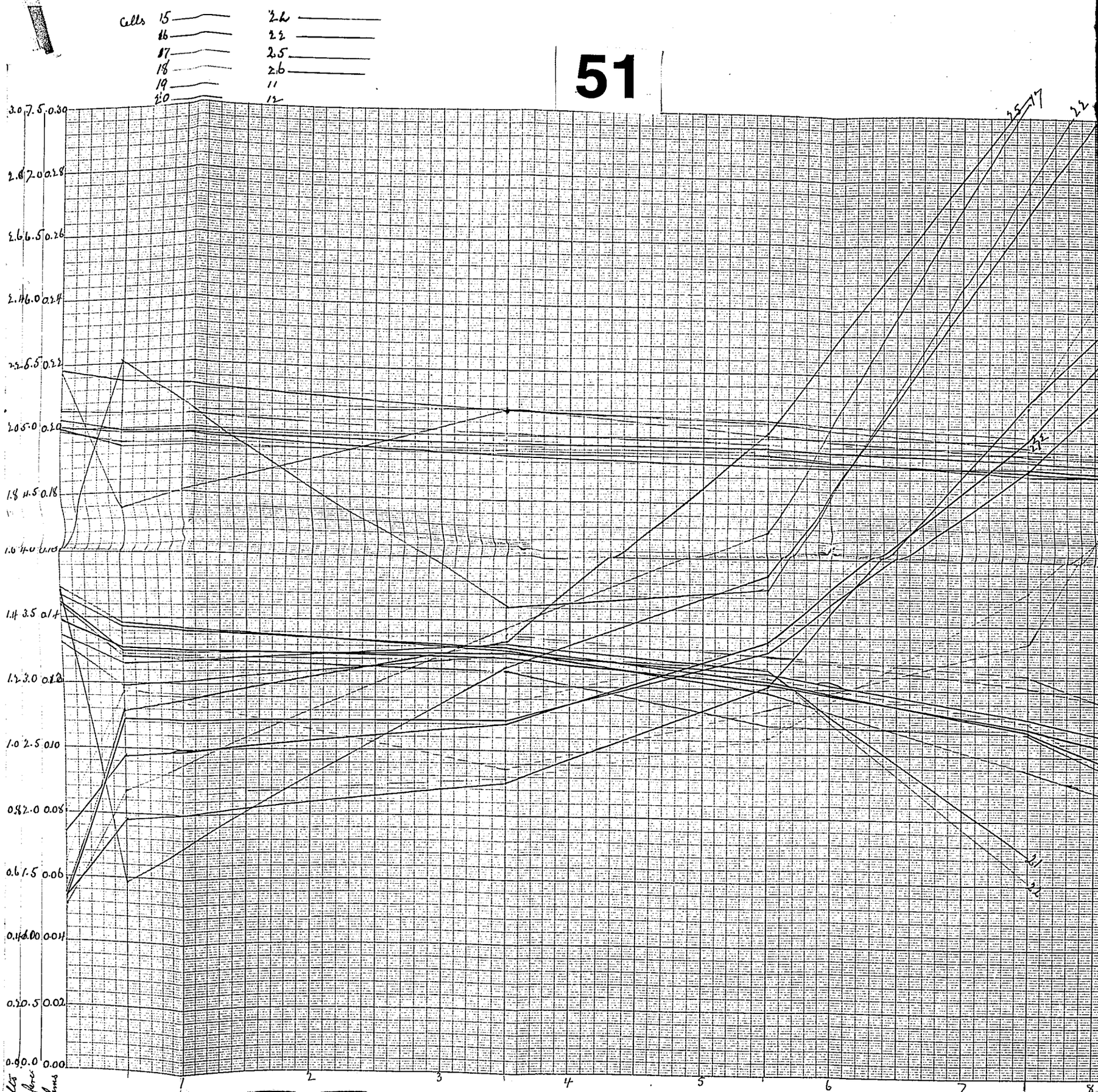


44

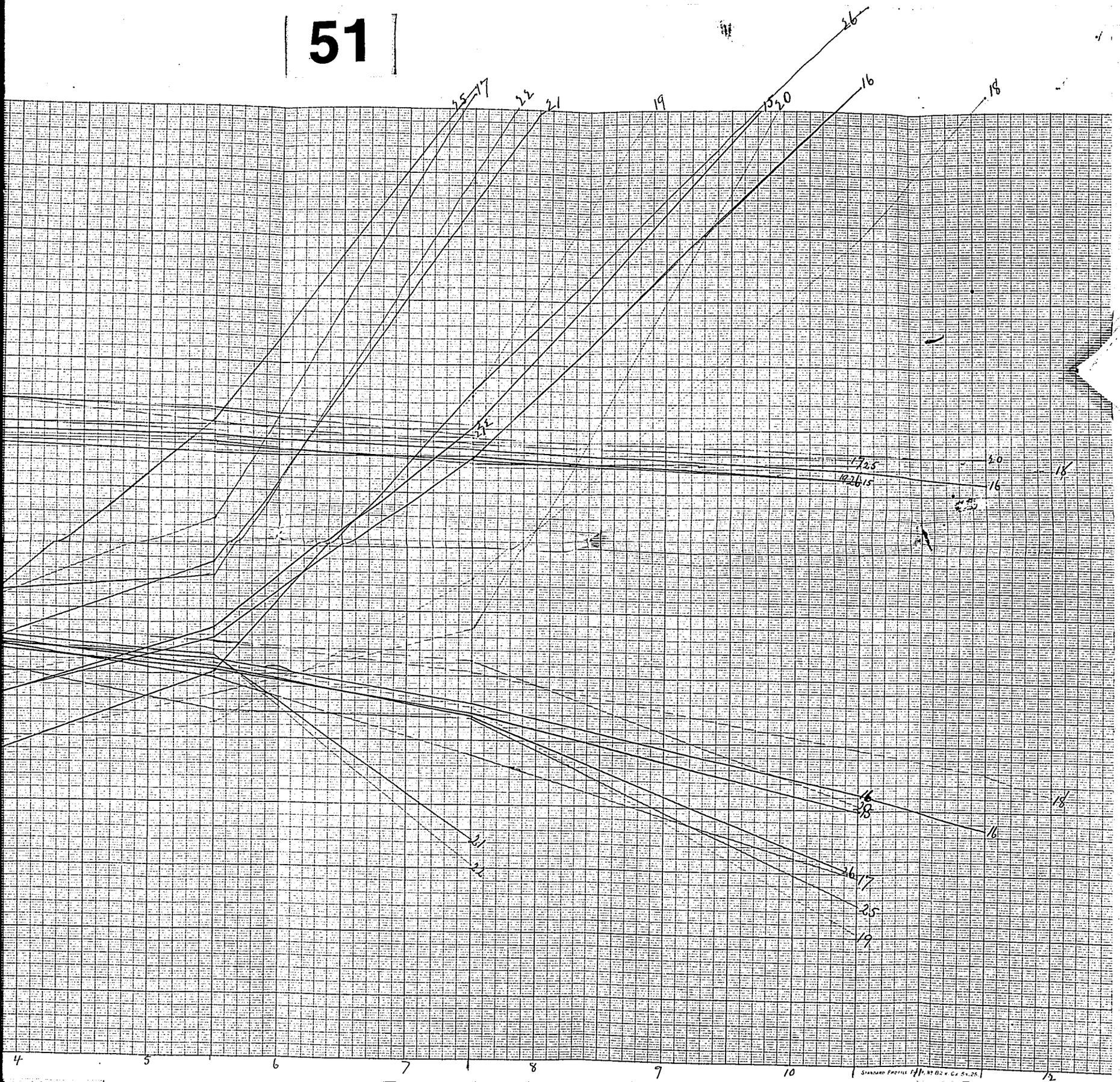
e Sulphuric Acid and 66.7% Water 27th July 1888
n their composition
presented by any of these curves
6% + 7% of Hyp. respectively. These call took 2 hours more than the others
to fall to 2 amperes on 0.5 in platinoid.

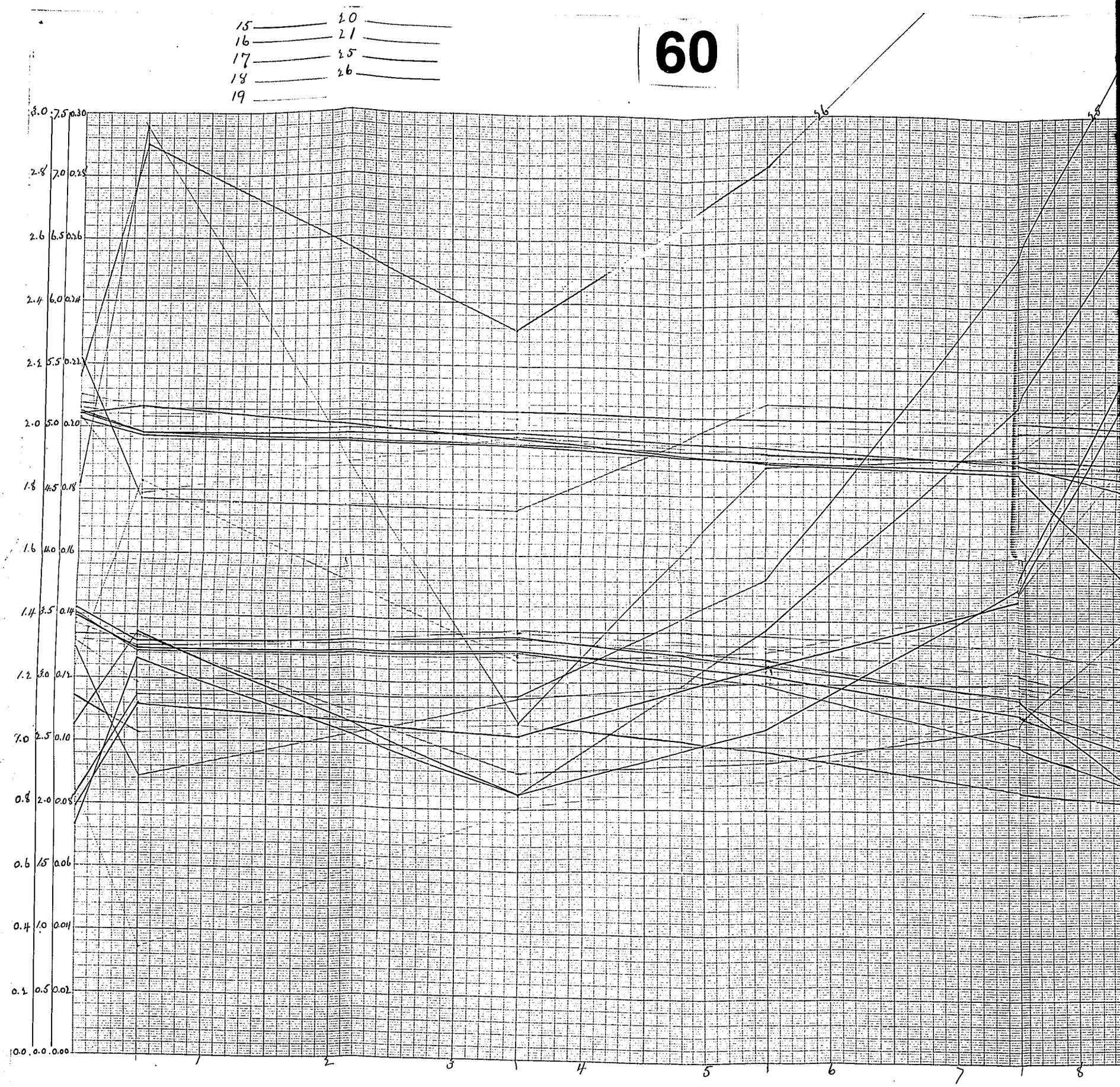


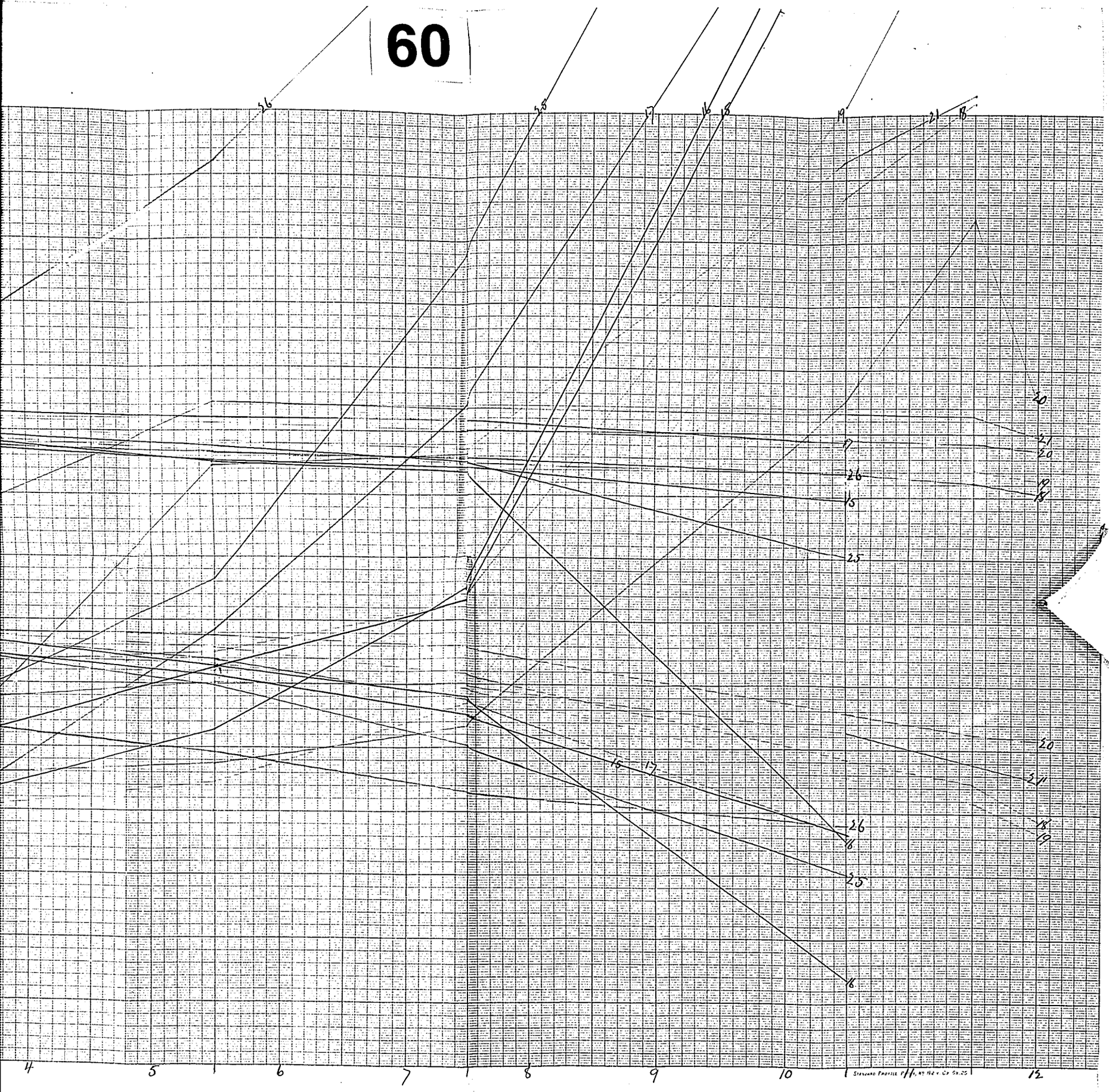

Curve showing exciting power required to produce induction in cloud wire circuit
Interpolar Distance Cms


Cells 15
16
17
18
19
20
24
22
25
26
11
12
3.0 7.5 0.30
2.8 7.0 0.28
2.6 6.5 0.26
2.4 6.0 0.24
2.2 5.5 0.22
2.0 5.0 0.20
1.8 4.5 0.18
1.6 4.0 0.16
1.4 3.5 0.14
1.2 3.0 0.12
1.0 2.5 0.10
0.8 2.0 0.08
0.6 1.5 0.06
0.4 1.00 0.04
0.2 0.5 0.02
0.0 0.0 0.00
1
2
3
4
5
6
7
8

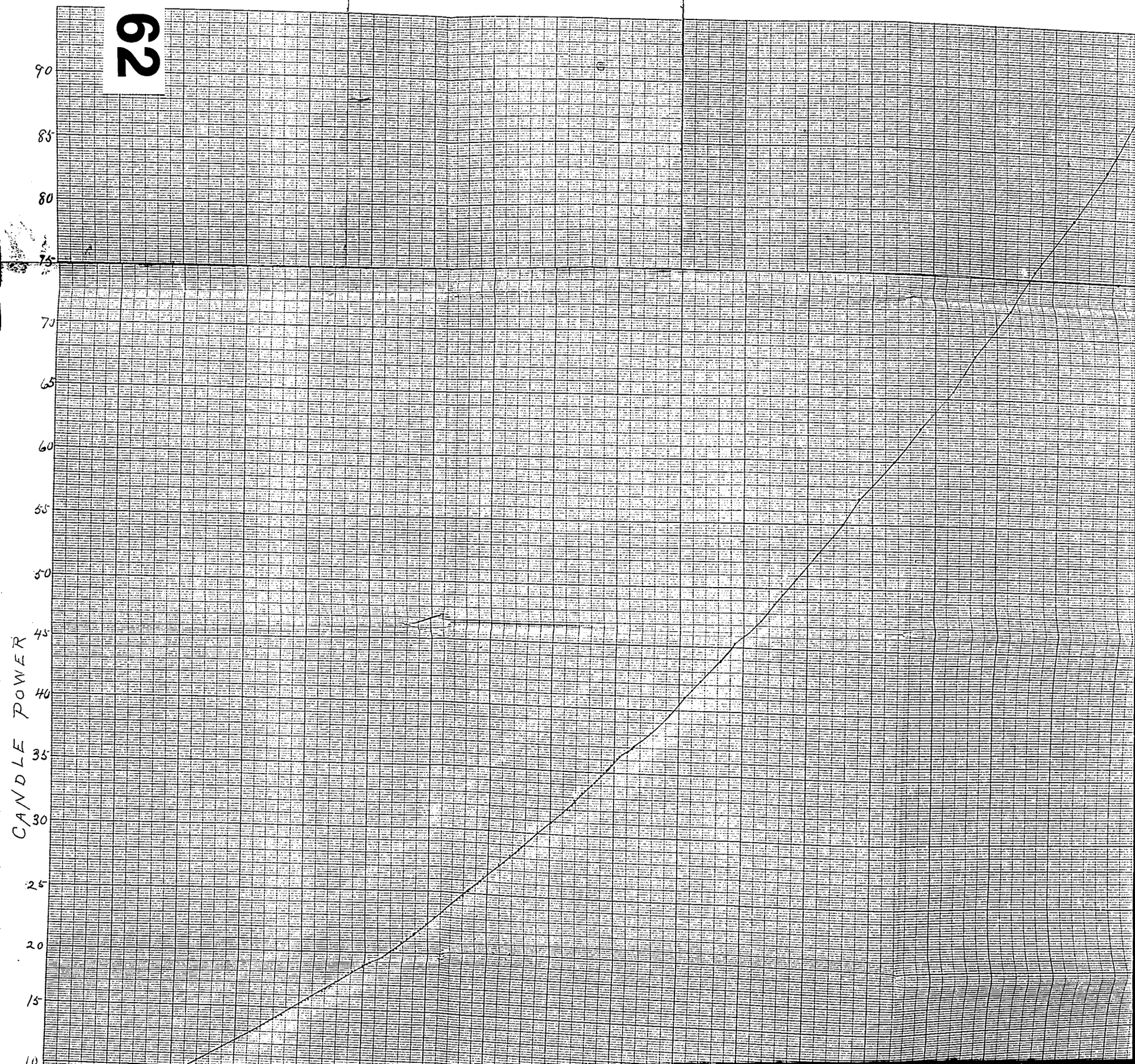
51

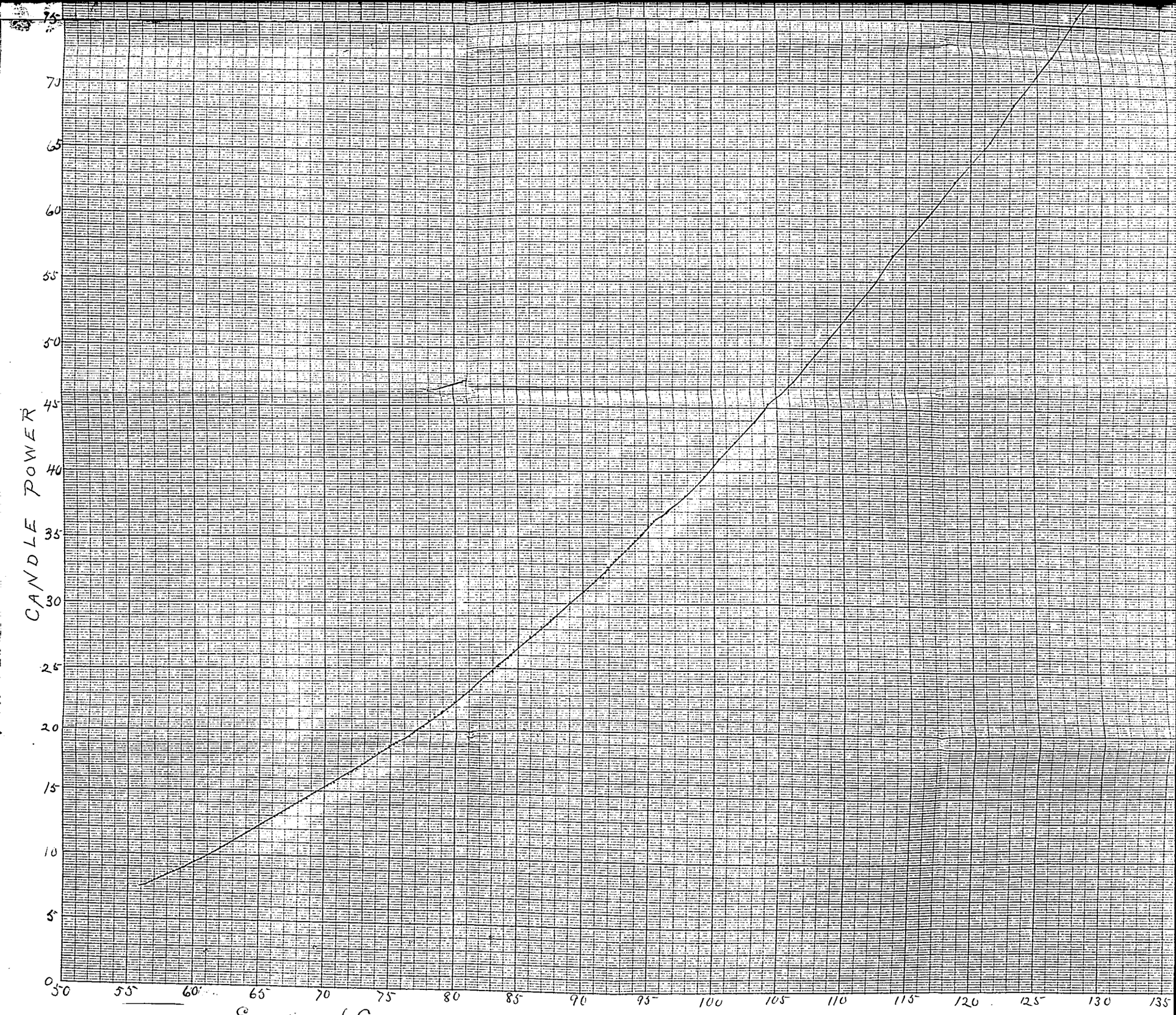



15
16
17
18
19
20
21
25
26
36
35
3.0 7.5 0.30
2.8 7.0 0.28
2.6 6.5 0.26
2.4 6.0 0.24
2.2 5.5 0.22
2.0 5.0 0.20
1.8 4.5 0.18
1.6 4.0 0.16
1.4 3.5 0.14
1.2 3.0 0.12
1.0 2.5 0.10
0.8 2.0 0.08
0.6 1.5 0.06
0.4 1.0 0.04
0.2 0.5 0.02
0.0 0.0 0.00
1
2
3
4
5
6
7
8


4
5
6
7
8
9
10
12

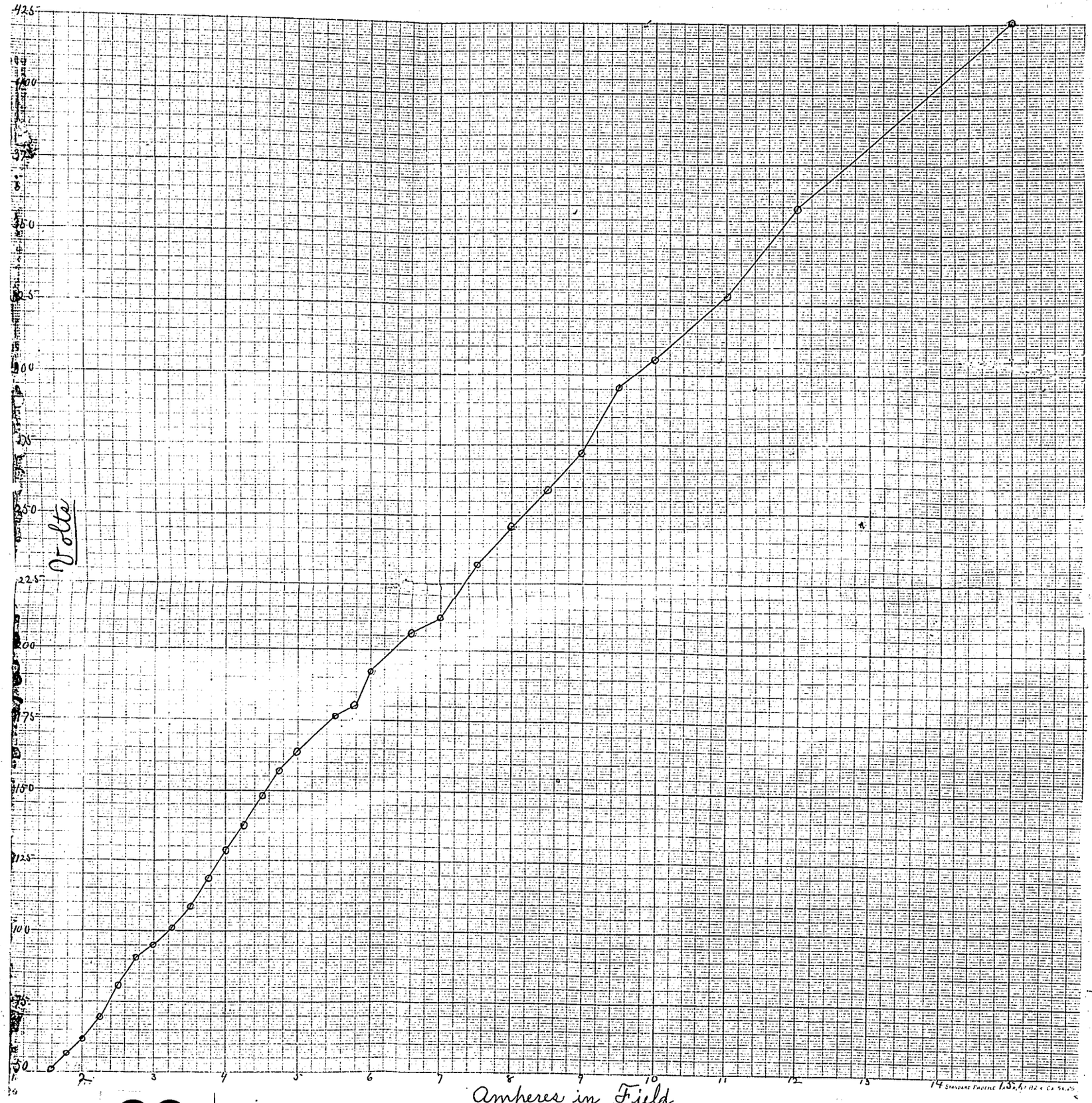
62





Equation of Curve
$y = .0062x^2 - .217x.$

62



Characteristic Curve
Siemens Alternating Machine.

Notebook, N-88-08-12

This notebook covers the period August-September 1888. It was used by Erwin Von Wilmowsky as a rough logbook for experiments, analyses, and various other daily operations in the chemical laboratory. Inserted into the book are several loose pages, including a note from Arthur E. Colgate requesting Wilmowsky to prepare chemicals for use in experiment number 162. That experiment was part of the search for an efficient battery for the phonograph. Transcriptions of these battery records can be found in Arthur E. Kennelly Notebook #6. The inside front cover is labeled "E. Wilmowsky's Dpt." According to a list of laboratory experiments, ca. 1903, this book was assigned the number "74." The book contains 189 numbered pages. Only 11 pages have been used.

Only a 2-page entry regarding the establishment of a "Meter Zinc Department" within the chemical laboratory has been filmed.

big copper still in Linseed oil bath.
The Plates were heated to 330°F.
One part of the Liban Turpentine Residue was fried from Turpentine by Naphtha another one by higher heat to 400°F.
Turpentine Residues were resp 1 lb and Liban 1 oz. Ether Residue 2 oz resp ½ oz Liban. insoluble Aragonic 3/4 lb. Spirit also was Liban. Benzol Residue not separated 6 oz.
Chloroform Residues 8 oz resp 6 oz
The Samples excl Loss did contain in Summa only 3 lbs each Shareforce 1 lb loss of Spirit and 1 lb of Liban Asphalt.
For these solutions c. 5 gallons 80% Benzol c. 9 gall Gasoline, c. 3 gall Ether, c. 6 gall Turpentine were used, whereof a part was regained by condensation, another part at last carried for cleaning all the vessels, another part lastly evaporated during the work.

On Aug. 25 '88. Meter and Battery Line.
The Meter Line Department is now full working order. The first 20 Meter Plates with Brass Rods (with 1½ Mercury) are delivered to the Galvanometer Department for testing. The Bath solution, after being cooled by the suspended Hydrate of Cerium and not stirred, is now 3 times daily by c. 6 cc conc. H_2SO_4 very slightly acidulated and kept clear in each bath.
The Electrolysis is only for Meter Plates, not, as hitherto, for Meter Solution.
The latter is made by bought C.P. Sulphate very slightly acid not neutral.
The Cathodes are suspended ½ inch above the bottom and the short circuiting thereby avoided.
The Anodes are now amalgamated to avoid the scaling off.
The 1½ Hg Plates gave good results.
The Solution which gave before a deposit containing Cerium Dioxide in the Meters, now all night being very slightly acid.
The Batteries are in series, daily hand 144 to 192 volts each. The Dynamo has 6 volt in open circuit. The solution is spec 1.08 to 1.21.
Each Bath has 5 Anodes and 5 Kathodes.
The current is 60 Ampères and mins 1 AM to 1 AM excl 12–1½ Summa 12 hours daily. This gives 8/10 lbs C.P. Zinc per diem on sixteen dbze Meter Plates.
Resistance of the Dynamo and Leads is 0.035 Ω.
Density is 26 Amp. for 16 □ inches.

The Mercury Alloys made for stokers and those made for Batteries were made by using a nick alloy containing 63% to 76% Mercury. 63% cannot be galvanized easily, 76% contains about one twelfth of its volume fluid metal, therefore 70% to 72% is the best. In making this nick Alloys there was a loss of 5%.

In making the other Alloys from 1 to 14% the loss did amount on an average to ½ of a percent, whereby the nick Alloy was used.

The five percent alloy was found to be the best for Batteries according Mr. Ed's statement.

All Mercury was washed with 20% Bol. in Nitric Acid and filtered through wood. The lumps of Zinc were molten without Carbon, Cyanide or Ammonchloride.

For 1½ to 19% Alloy these were made at first 3 Battery plates of each then of 70% in forty pieces and then of 5% in 45 pieces. For Electrolysis in with 5% Hg four plates were made for Battery test. All Plates contained according analysis the stated amount of Mercury within narrow limits. Nick contained of 8% Hg and 92% Zn only 0,25% Hg.

Th. Sept 6' 88.

For making Hexachlorbenzene (C_6Cl_6) 474,50 gr. Benzene + 2 lbs Antimony Pentachloride were put in a Florence flask with 3 gallons condenser and a stream of dry chlorine conducted 1½ days to the surface. The heat after rise to c. 50° C by the reaction only on the outside, the mass solidified inside. The resulting black crystalline mass washed by hydrochloric Acid until all Antimony was removed.

Notebook, N-88-08-23

This notebook, which covers the period August 1888-October 1889, is a continuation of N-87-01-01. It was used by Jonas W. Aylsworth to transcribe the results of experiments, nos. 831-1090, on wax compounds for phonograph cylinders. The rough records of these experiments can be found in N-88-01-02, N-88-11-13.3, and N-89-05-30.2. The front cover is marked "#565" and "United States Circuit Court District of New Jersey American Graphophone Co vs National Phonograph Co No. 10 March Term 1905 Defendant's Exhibit Aylsworth Note-book No. 565." The book contains 187 numbered pages. At least one page was removed before the book was paginated.

N-88-08-23

Should be #565
see outside cover
#564 is N-870101

564

Dorothy Cerwath
July 31-89

XE-2449

1

Oil samples Wednesday 1.

Continuation of Book 5 C 4 L. 1.

#10 O.S.

Fatty acids precipitated from Ceylon Cocoa nut Oil by saponification and H.Cl.

#11.O.S.

Fatty acids obtained from poor grade of C.N. oil by saponification and precipitation by H Cl.

#12 O.S.

Fatty acids in similar manner to above from No 2 Cocoa N. Oil - 100
Oleic acid — 15

#13 O.S.

Ceylon Cocoa nut Oil at present worth in large lots about 6 1/2 ¢ per lb.

#14 O.S.

Poor grade #2 of Cocoa N Oil at present worth in large lots, about 5 1/2 ¢ per lb.

#15-O.S.

Oleic acid treated with hydr. chloric acid just enough being used to convert more than ½ into chloride of same, the fat not converted, filtered.

Continuation of

Metallic Soaps from Book, 5-64,

(2)

No			
			8/23/88.
31.	Cocoa nut Oil ~~#2~~	—	200 gm.
	Oleic Acid	—	30 "
	Sham Sol lye	—	138 cc

Saponified by heating, to white semi transparent mass. Clear solution in hot H_2O. Precipitated by acetate lead, to white granular hard mass - like that of #30. Melted down was like #30 except slightly more transparent & hard slightly better cut.

32.	Cocoa nut Oil #2 =		300 gm
	Sham Sol lye	—	180 cc

Fatty acids precipitated from aqueous solution of soap. Part of fatty acids obtained — 264 grams a loss of 11 5/16 % in glycerine and volatile fatty acids.

Bring up -!

No. Mutatis Soaps

833 Cocoa nut Oil #2 — 200 gm.
Oleic acid — 201 "
Stron Sol Lye — 132 cc
Saponified to white soap, in action and appearance was like #30 & #31.
Precipitated by acetate lead, to white mass like that of #30 & #31.

8/23/88.

834. Cocoa nut Oil — 200 gm.
Oleic acid — 40 "
Stron Sol lye. — 144 cc
Did not entirely saponify — soap amber colored - rather cloudy solution in H_2O.
Oil that floated on solution skimmed off. acetate lead precipitated white gran. slightly acid mass melted to clear liquid & cooled to very transparent mass cut fine - fracture fine - appearance but so hard.

Mixed Metallic Soaps 8/23/88.

835 Portion of soap solution of #833 precipitated by mixture of about equal parts magnesium & lead acetate. Formed white adhesive mass. Melted down to clear liquid & cooled transparent, more so than #831. Cut good - worth experimenting on.

8/23/88.

836 Portion of soap solution of #834 prec'p'd by mixture of lead acetate & magnesium acetate 1 of lead to 2 of mg.
Formed white adhesive mass. Melted down to clear liquid. cooled to dark amber mass more transparent than #835.

No. Mutatis Soaps 8/24/88.

837. Cocoa Nut Oil #2 — 200 gm
Oleic Acid — 40 "
Stron sol lye — 168 cc
Same as # 34 except in mass of lye.

838. Cocoa Nut Oil # 2 — 8/24/88.
200 gm
Oleic Acid. — 50 "
Stron Sol lye — 150 cc.
Saponified difficultly but by prolonged heating turned into rather dirty hard, white soap which gave fairly clear solution in hot H_2O.
Precipitated by heat lead to white hard granular mass, granular size of shot.
Very nice to work: when melted clear, when cold whitish
Transparent - not good - slightly tough + more adherent than Nut Oleic

No. Imitation Soaps 9/24/19.

839. Fatty Acids from #2 Cocoa N. Oil) 100 gram
Oleic acid — 25 "
Stem Sol lye — 91.5 cc.

840. Cocoa N. Oil #2 — 1000 gram.
Oleic Acid — 200 "
Stem Sol lye — 780 cc.
Same as #834 only increase
of 5 cc of lye per 100 cc Oil,
Acted similar to #834.
This was made nearly e.p.

No. Metallic Soaps. 8/21/88.

941. Cocoa Nut Oil — 1000 gm.
Stan Sol Lye — 600 cc.
Saponified by continued application of heat but did not give clear solution in water, even after prolonged boiling — a hard white scum formed on top of solution. Precipitated by acetate lead to white wax adhesive when hot, hard and granular when cold.

8/30/88.

942. Cocoa nut oil — 100 gm.
Sol lye sp gr 1.40 — 50 cc.

8/30/88.

943. Cocoa nut oil — 100 gm.
Oleic acid — 5 gm.
Sol lye — 40 cc.

No. Unguentic Soap. 9/30/88.

944. Stearic Acid — 100 gm.
Cocoa nut Oil — 50 "
Olein Acid — 10 "
Sol Lye 1.40 sp gr 48 cc.

9/30/88

945. Stearic Acid — 100 gm.
Cocoa Nut Oil — 50 "
Olein acid — 15 "
Lye Sol 1.40 sp gr — 49.5 cc.

946. Stearic Acid — 100 gm.
Cocoa Nut Oil — 50 "
Olein acid — 20 "
Lye Sol — 1.40 sp gr — 51 cc.

No. Nitrate Soaps. 9/27/17.

847. Cotton seed oil — 100 gm.
Sol lye — 80 cc.
Saponified with difficulty to yellowish soap. clear sol, precipitated by $C_4H_4Pb_2O_4$ to sticky mass.
When melted PbO released. Probably too much lye was used that is not all the fat saponified and what did took long chain of lye which is substituted by equivalent quantity of lead when precipitated.

848. Cotton seed oil — 200 gm.
Lye sol 1.4 sp.gr. — 80 cc.
Saponified similar to #47.
Precipitated by ~~HCl~~ acetate lead to white sticky mass
When melted assumed oleate. Which except slightly yellow color

No. Metallic Soaps. 9/31/97.

949. Cotton Seed Oil — 100 gm.
Stearic Acid — 100 "
Olein " — 50 "
Sol lye — 1.4 — 100 cc.
Saponified 5 hrs to clear solution precipitated by $C_4H_6P_2O_7$ to sticky white mass melted down to crumbly cotton mass.

9/31/97.

850. Stearic Acid — 100 gm.
Cotton Seed Oil — 66.6 "
Sol lye — 2 cc.
Saponified to hard granular soap, clear solution
Precipitated by lead acetate to rather flaky mass
Rather rotten Solution melted down, cut fair but weak.

No Metalic Soaps. 8/31/89.

86, Stearic Acid — 100 gm.
Cocoa nut Oil — 44 "
Oleic Acid — 22 "
Ley solution — 49, 80 c.c.
Saponified with difficulty to granular dirty white soap.
Fairly clear solution.
Precipited by acetate lead to finely divided white mass, melted - clear + hard gray, foundry cut when cold.

86-2, 8/31/89.
Cocoa nut Oil — ~~100~~ 44 gm.
Stearic Acid — 100 "
Oleic Acid — 30 "
Sol ley — 30 c.c.
Acted like #87 + appeared the same slightly less powdery to cut.

No. Metallic Soaps. 8/31/38.

95-3. Stearic Acid — 100 grm.
Palm. Oil (crude) — 44.5 "
Cotton seed Oil — 22.5 "
Sol Leg. 1.40°. — 67 c.c.

8/31/38

A serious obstacle was here found in all cylinders made of cocoa nut oil, palm oil, cotton seed, and in fact all the oils and fats, in the shape of minute bubbles which could not be seen by the naked eye, but could be very distinctly heard in the phonograph as a crackling and scratchy noise and, could be seen under the microscope. These were found, after a series of experiments, to to be caused by glycerin, decomposing slowly while the mass is melted

giving off acrolein & water, also to the reformation of the glycerine.

It was found that glycerine always occured in the wax makes it was especially well made and washed, with alcohol after precipitating or other processes which would make it to expensive for practice. The point at which these bubbles formed could be raise by heating the melted wax very hot and letting it settle and then to the temperature required in molding but this operation spoiled the quality of the wax, and then great care had to be taken to run it high enough each time and not to let it get to high in molding. which also gether made it impractical.

So the only way left was to use fatty acids and not nutral fats or oils.

No. Metalic Soaps

354. Strongly oxydized linseed oil, 200 grams heated with 70cc of 1400° lye solution boiled to dryness then water is added and boiled untill it looks like soft soap; then it is precipitated by acete lead.

355 Same solution as 354 precipitated by alum.

No. Metallic Soaps.

956. Stearate of alumina made by fusing stearic acid and chloride of alumina, together adding the latter little by little untill the mass becomes thick even at high heat.

957. Stearate of Soda.
made by adding dissolved caustic soda to melted stearic acid. It must be added slowly to the acid, and after some is added the higher stearate formed is allowed to ~~settle~~ dissolve in the stearic acid, more heat being applied as the melting point of the mass raises, as more soda is combined with the stearic acid. To 1000 gm

No. Metallic Soaps.

of stearic acid about 100 gm of Na HO (Lewis) was used. This makes a soap, of a light brown color, with a very high melting point, which when poured out and cooled becomes amorphous on the cooling surface but crystalline on inside. It is almost perfection on the phonograph (the amorphous outside) as far as articulation cut and scratch are concerned, but when the cooling surface has been cut through it becomes scratchy and, no good, also it will absorb moisture on hot damp days, which would spoil any record put on it.

No. Metallic Soaps

858. Stearic Acid 5.00
NaHO. (Sol.) 3.7 } dissolved in
acetic Ac. (Glac.) 1 3/H_2O, together.

The object of this experiment is to take the crystalization out of stearate of soda, and to make it mold better. It came out heavy up, non crystalline, good cut, molded first class - but was electrical. Not so likely to absorb moisture.

859. Stearate of soda No 85-7, melted with about ½ ~~stearate~~ of Mg. (made by adding acetate of Mg or common ~~Mg~~ magnesia to fused stearic acid, untill a trans parent amorphous mass is obtained which has a slightly brownish yellow color.) This makes a wax with a very good cut, non electric, strong, but had

No. Metallic Soaps.

too high a melting point to be practical.

860. Stearic Acid 1000 gm.
Acetate of Barium about 100 gm.
Fused together.
Forms a hard high melting point amorphous solid which has a poor cut.

860½ #860 With free stearic acid.

861 No. 860 mixed with No 855 in various proportions none of which were as good as No. 858.

862 Stearate of Strontium, made same as No 860 which it much resembles.

It was after word found that #864 changed on surface after standing a while becoming porous. It is really a mixture of or compound of ~~stearate~~ of Al & acetic acid, the latter of which evaporates when #864 is heated very hot it loses its white waxy appearance, and becomes distinctly crystalline. This has a remarkable contraction when cooled in series four.

No. Metallic Soaps.

863 Stearate of Strontium mixed with #857 in various proportions. Good but not equal to #858.

864 ~~Stearate of~~ Al. (white)
To fused stearic acid acetate of Al is added untill a white hard non crystalline, cohesive to cut, wax is obtained. It forms a liquid about as thick as No 857, which solidifies at very low tem, in fact it can be poured in the hand and left to cool, but when once solid its melting point is very much higher. Molds good, is moldable, lathes good cuts good, contracts scarcely any in mold, does scratch thin 85-7, very identical.

No. Metallic Soaps.

865. Stearate of lead mixed with various proportions of stearate of alumina,
None of these equaled #858.

866. Stearo Sulphuret of Soda.
Made same as No 857 except hydro sulphuret of soda (NaSO) is used in place of NaHO.
This gives very good wax which is very similar to No 1, and if any thing better. But #858 is better and more practical.

867. Stearic acid — 1200 gm.
Lewis Lye (com) 900 "
acetate Al (sic) 433 "

11 M.O. Metallic Soaps

acetate of alumina and dewis' lye are dissolved together in water so as to make a concentrated solution. The stearic acid is melted in iron kettle and heated to 240° F then the solution is added same as in No. 857 the temperature ranging between 240° to start and 380° at finish. This is cooked a day and a half or until bubbles stop coming. This is intended as a duplicate of # 858 except a little more soda & alumina is added. Came out same as # 858 except a little better. It was of a reddish color due to iron kettle. This material when cooked at

No. Metallic Soap

a high temperature (400°F.) is much improved but is rendered less easily molded, on account of the melting point raising.

This wax seems all right except if a very dif. trade is made by the phono needle it slips out; seems to be a little too much Al. in it.

968. Stearic Acid 2000 gm.
~~Acetate Al.~~ (not sic) 72 "
Lewis lye 153 "

Done same as # 867 except it was done in chili pan.

This was a slight improvement on # 867.

No. Metallic Soaps.

869. # 867 with a little lye and stearic acid added.
This is much better and only remains to get correct proportion to make it O.K.

870. No 867 heated up to 500° F. for some time.
Somewhat improved

871 # 867 – 300 gm.
Stearic Acid 50 "
Caustic soda 5 "
This is very good in all respects and when filtered is perfection almost.

872. #871. Duplicated.
Came out the same.

No. Mutatis Soaps.

873. Stearic Acid 50 gm.
867 — 500 "
Caustic Soda 10 "
Very good only little harder to mold and filter than No 871.

874 Third duplicate of # 871 came out all right.

875. Fourth duplicate of # 871.
Caustic soda & crystals of Al. dissolved in water same as 867, this is filtered, and when measured out equals 2370 CC of 1,3800 Sp. Gr. at 80° F.
Stear — 1400 gm.
Soda — 1100 "
Al — 440 "

No. Mutalic Soaps.

In making the temperature did not exceed 390°F. After all the solution had been taken up it was kept at about 360 or less for half a day. It took 1½ days to make.

974 #371 is melted and heated to 360°F then filtered through filter paper, in oven, filters very slow, about a drop in two seconds or less. Makes perfect cylinder when filtered

977 On ~~molding~~ #371
The material is melted and heated pretty hot, untill it gets dark in color; this is then filtered through chinese ~~[illegible]~~ cloth and molded in mold heated to

No. On Molding & filtering

130° F. The mold was not hot enough, and the consequence was a seam down the side of cylinder where the wax was first poured in.

876. Same as # 877 except it is molded in old mold with cold core, and shell heated to 130° F. Shell was wraped with asbestos paper. This came out fairly good.

879. Temp of wax 329° F.
" " mold (shell) 212 F
" " " core 212° F.

Molding.

880. Temperature of wax — 350°F.
" " mold (shell) 212°F.
" " " core 90°F.

Time left in mold before withdrawing 18 min.
The wax was found in best. This cylinder was better than #879, but had sunken in places on outside of cylinder, caused I think by air bubble which is greatly expanded while hot and which collapses when cold, the bubble might be very deep in the cylinder.

No Molding #871.

881. Tem. of mold (shell) 72° F.
" " " (core) 72° F.
" " wax 360° F.

Mold is jacketed with asbestos on the outside,
Material poured in fast.
Stayed in 10 min. when water was poured on inside of core to cool it so that it could be withdrawn,
Came out fairly good.
but was slightly sunken in large spots.

882. Tem of Mold (shell) 90° F.
" " " (core) 90° F.
" " Wax 350° F.
Used the thin core belonging to old mold of which old no)

No. Molding, # 821.

833. Tem of mold 70° F
" " wax 350° F.

Heavy core, wound with Ulricd Clarks #30 spool cotton.
This molded very good tho was sligh seem left in one side where the stuff was poured in. The core came out nicely leaving the inside beautiful.

834. Tem of Wax — 350° F.
" " Mold (shell) 140° F.
" " " (core) 80° F.
Heavy core, wound with Clarks' spool cotton # 24.
Poured in wax medium fast.
Came out very good except for slight roughness on surface

No On molding 871.

885 Same as # 884. except inside of mold (shell) is polished and gate is heated to 300°F.

886. Tem. of mold (shell) 120°F
" " " core 78°F
" " work 325°F

Core wound with #40 Clarks' thread
inside of shell of mold
lined with parchment paper.
Came out wrinkled from the
warping of the paper but wrinkles
were fine and not very deep
No seam was left on cylinder
Very good.

No. Molding #15.

887. #15 (not filtered)
Temp of mold (shell) 130°F.
" " " (core) 130°F.
" " wax 350°F.
Core wound with No. 40 (Clarks) thread & inside of mold lined with writing ~~paper~~ tape.
Came out with less wrinkles but what there were, was very deep and long.

888. Temp of mold 100°F
" " wax 325°F.
Cotton thread ~~with~~ wound core, inside mold, lined with tissue paper.
Wax run on both sides of paper. no good.

No. ~~Filtering~~ # 871
~~Modelling~~ # 871.

889. Filter heated by gas shaped thus

Sum of wax in filter 350°F
amount per hour – $10\frac{1}{2}$ oz.
common filter paper
box used

890. Same as 889, only this is result of second hour. only about half as much come ~~through~~.

891. Large size cylinders weigh $3\frac{3}{8}$ oz just as they come out of the mold.
or $96\frac{1}{2}$ gm
30.9 lb wax = 144 cylinders.
30.9 lb = 14000 gm.

Standard Solution of Lay and Alumina Acetate.

Lewis Soda — 1100 gm.
Acetate of Al(dy) — 440 "
Dissolved in enough water to make sp. gr. equal 1,3800 at 60°F. after filtering.

1400
464 [illegible]
1cc = [illegible]

No. Molding 8H

392. The best proportions for #871 are —
To 14000 gm stearic acid, use 2370 cc. of standard solution of lay (see opposite)

393. Cylinder molded same as #871, except core is wound with thread, and gate of mold is heated to nearly same temp as wax. After filling the gate with wax opened the gate and let it go in as fast as it would, forming at same time, came out bubbly.

394. #871 filtered through twill. Wax at about 360°F in filtering came through fairly fast.

No. Molding & Filtering.

895 Tem of mold 200°F.
" " wax 340°F.
" " gate 300°

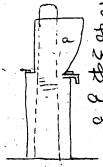
Core thread wound inside of mold lubricated with glycerine after cylinder is cold it is coated on inside with elastic lacquer (gun cotton in acetate of amyl) to make the thread stick tight. Any color could be given to the inside in this way, by dissolving ~~the~~ colors in the lacquer. The thread sticks very well.

896 Done in gas heated filter.
Tem of wax 330°F.
Used twill muslin as filter medium.
Amount fe from 1 lb 2¼ oz.

No. Filtering & Molding.

897. Same as # 896, with a new ray and temperature a little hotter.
Amount per hour - 2 lb 3 oz.

898. Molded in large gate mold as shown - —



Thread covered core
The gate filled up with the cut off closed then the cut off opened and gate filled up again.

Tem of wax	240°
" " mold	212°
" " core	100°
" " gate	240°

No. Molding.

899. Same mold as in 898.

Tem. of wax 340° F.
" " mold 55°
" " core 100°
" " gate (a) 240°

Core thread wound.
Gate filled with cut off closed then gate opened and filled again, to give pressure to that which is already in.

900. Mold made with jacket on outside to pass cold water, or steam as the case requires.

Set of mold.

The mold was warmed a little, and the wax poured in at 360°. Immediately after wax was poured cold water was forced through the jacket, the cylinder came out a true cylinder, perfect, not a rough blow or out side, too expensive

No.	Molding
901	Mold wrapped on outside and in the center with copper wire so as to give more mass of metal at center, and to keep the cylinder from warping in center. Worked in a medium.
902.	Core covered with paper, ordinary news paper, came out nicely but cracked when it became cold.
903.	Core wound with heavy string cracked.
904	Core wound with silk thread did not stick good.
905	Core wound with spiral strip of paper. good, no crack.

No. Molding

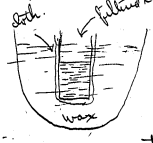
906. Core thread wound, found at regular turn (350°-360°) in slightly warm mold.
Cylinder left on core untill it had become dead cold.
It did not crack and was perfectly true in side.
Cooling in this way will insure perfect fit on mandrel of phonograph.

907. Core not thread, wound, found at regular turn, in slightly warm mold. Left in untill dead cold.
Came out all right did not crack.
In others tried in this way some of them did crack however.

No	Molding
908.	Core wound with coffee wire. Came out very good, but the expense of wire is too great
909.	Core wrapped with muslin. Came out fairly good, but cracked, after it had stood several days.
910.	Wax heated to 500° poured at this temp, into cold mold. The idea of this is to see if the mold won't stay liquid long enough while in the mold, to allow the bubbles to raise to top. Bubbles were found in the cylinder, mostly fine ones, the larger ones having risen.

No. Filtering # 621.

911 A cylinder is made of iron nutting about 5in diameter and $1\frac{1}{2}$ ft long, this is covered with muslin (twill) and sunk in molten wax, the top being left open. Following is view of filter in wax.



This arrangement filters more than 10 lb to the hour.

No. Molding # 871.

912 Old thin cylinder mold was used it having a thin skulled core.

Tem. of mold 60°
" " wax 340°

Poured in medium fast.

This cylinder came out perfect.

From this experiment, it shows that the ~~core~~ thickness of the core in relation to that of the outside mold has a great deal to do with the sunken-in flows of the cylinder.

No. On ~~[illegible]~~ making # 871 Non electric.

913 #. 871 — 100 gm.

Balsam (Canada) 5 "

Softened it some, but improved ~~the~~ cut. Taking electrical property of #871 as 10. this one would come at about 7.

914. # 871 — 100 gm.

Canada Balsam 3 "

Very good wax, polish cut, more cohesive.

Electrical — about 8,

915 No 871 — 100 gm.

Camphor — 5 "

Barry wf.

Electrical — about. 5.

No. Making 871 non Electric

916 # 871 — 100
Caramel — 5
no good.

917 No 871 — 100
Salicylic Acid (camorfle) — 5

918. #871 — 100
Benzoic Acid 5.

919. # 871 — 100
Gallic Acid — 5

920 # 871 — 100
Pyro Gallic Acid — 5

921 # 871 — 100
Tannic acid 5.

No. On Non Electric frying # 871.

922. # 871 — 100
Alpha Naphthol — 5

923. No 871 — 100
Silicate Soda — 5

924. # 871 — 100
Chloride Zinc 5

926. # 871 — 100
Alum — 5

927 # 871 — 100
Borax — 5

928 # 871 — 100
Venice Turpentine — 5

929 Chloride of ammonia 5
871 — 100

Considerable softer than # 871, about as soft a carnauba 100 ceresin 30. Hardens on surface after time.

No. On Moth & Electric fyring # 871.

930 # 871 — 100
Arsenious acid 5.

931 # 871 — 100
Tungstate Soda — 5

932 # 871 — 100
Molybdenic acid 5.

933 # 871 — 100
Zinc Oxide 5.

934 # 871 — 100
Chromic Oxydat 5

935 # 871 — 100.
Talc — 5

936 # 871 — 100
Fe. Chromic — 5

937. # 871 — 100
Carnauba — 24

Too Soft.

Crystaline.

The best yet. Scarcely any electrification, while #871 is tenable. Probably this great change is caused by evaporation of camphor which carries away the electricity.
Not practical as the camphor will evaporate leaving a poor surface.

The best talking up to now obtained on this one, not a sound to be heard other than the talking, with the exception of slight crackling noise and than.
Somewhat electrical.

No On Non Electrification of #871.

938. #871 — 100
Camphor 10.

939. Sharate of soda 100
Camphor 10.

940. #871 — 100
Camphor 5.

941 #871 — 100.
Cofabia Balsam 7.

942. Cofabia Balsam 5
#871 — 100.

Bang Up!!!

No. Skin Electrization of #871.

943. #871 — 100
C ofabia 5 } 100
C amphor 5.

944 #871 — 100
Oil mace — 5

945 #871 — 100
Fatty oil Cassia 5

946 #871 — 100
Oil Cassia — 5

947 #871 — 100
Balsam Sulphur — 5

948. #871 — 100
Tymol — 5

949. #871 — 100
Red cedar oil — 5

No. Non & Electricalization of # 871.

950. # 871 — 100
Copaba — 3
Camphor — 5

951½ No 871 — 100
Copaba 3
Camphor 5

951 # 871 — 100
Rosin from Balsam Copaba — 5
Camphor 5

951½ Steam — 2000
Stand sol. 475 cc

952 # 871 is adapted as regular and not made in phonograph Records
63425 gum — Steam.
Stand solution 15# 063½ cc
came out good but was finished from the rim of kettle.

See N-8511 13
page 89-91
(Pitts)

Dec 6th 1888. (95)

No. On Preserving Records of Sounds on Wax Cylinders

953 The idea is to coat the cylinder with a thin film, that will not wear under the influence of the (receiver or reproducer) stylus, or by handling set. Such a film might be a seperate compound as colodion, varnishes, silicates, (colloids)

The might be ~~obtained by~~ applied by brush or by dipping ~~in~~ solution of the film required; the solvent afterward drying and leaving the film on surface of wax.

Or the cylinders might be composed of asphalt compounds or something which when after wards treated would become hard on surface. This might be done by fuchsline

Some difficulty was encountered in the shape of bubbles which would form in putting it on
The talk was not harmed

Did quicker, and came about same as # 954.

No. Preserving records.

of antimony and other chemicals.

954 Guncotton applied in solution of alcohol, ether and acetate amyl, by a camel's hair brush, the cylinder being revolved while applying the solution

953 Solution of guncotton in acetate of amyl, ether and alcohol, less amyl being used than in # 954.
Must be applied quick and not rubbed much with the brush.

956 To be continued when have more time.

This made every thing O.K. and was accepted by Mr. P. as regular for the time being, or untill something better turned up.

No. Softening #871.

956. Trouble was found in working #876 in phono works as it would not turn smooth in the knives we had, and when they did get a good knife it would not keep in good condition long, making it impractical to work, so the following experiments were made to soften #871 a little.

2000 gm Steam.
200 " Red oil
500 cc standard solution

957. Steam and 3000 gm.
Red Oil 150 "
Stand Solution 750 "

crystalin, but gave good cut on cooling surface (little soft) too much solution used.

Gave remarkable phenomenon in crystalization. Fig 1 shows elevation of cylinder, ~~and~~ Fig 2 sect ion a-b of Fig 1.

Fig 3 shows plan.

In fig 2 each dark ring indicates the amorphorous layer and space between the crystalin part, there were ~~were~~ 4 distinct layers of ammorphous wax, which extended all the ~~way~~ way around the cylinder, 2 being inside the wall.

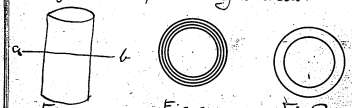


Fig 1. Fig 2. Fig 3.

No. Improving # ~~X~~ 871.

958. Stearic acid (very crystalin) 5000 gm
Spermaceti 1500 "
Stand solution 170 c.c.

Very hard and cohesive, and not nearly so electrical as #871

No. Improving ~~871~~ 871.

959. Stearic Acid (very crystalline) 500.
Linseed Oil Boiled — 30
Stand solution leg — 170 c.c.

960 #871 — 100
Spermaceti — 12.

961 # 871 — 100
Syr. Asphalt — 10

962 # 871 — 100
Syrian Asphalt — 5

963 # 871 — 100
Syr. Asphalt — 20

964 #871 — 100
Soft. Mix. Asphalt — 5

Camphoric guncotton is the product formed by adding guncotton to hot melted Camphor. The guncotton seems to decomposed and dissolve in the camphor. Makes an amorphous tough yellow waxy mass.

No. Improving 871.

965. # 871 — 100
Soft Mex Asf — 10

966. # 871 — 100
Soft Mex asphalt — 20

967. # 871 — 100
Soft Mex. asphalt — 5
Sulphur — ½

968. # 871 — 100
Camphor and guncotton — 5
(see Aphorite.)

969. # 871 — 100
Camphoric guncotton — 10

No. Improving # 871.

970. # 871 — 100.
Linolic acid — $1\frac{1}{2}$

971 Camphor melted and boiled with HNO_3 until it turns black HNO_3 is renewed from time to time.

972 # 971, with guncotton dissolved into it while melted.

973 Camphor and linseed oil intimi- mixed and oxydized by ~~linolic~~ acid.

974 # 871 — 100
971 — 10

975 # 871 — 100
971 — 5

979 (b)

High Oleate of Lead, is formed by saponifying oleic acid with all the potash or soda it will take and precipitating by acetate of lead. Has been dissolved in ~~methyl~~ acid alcohol evaporated.

No. 9 improving # 871.

976	# 871 —	100
	#973 —	3
977	# 871 —	100
	#972 —	5
978	#871 —	100
	#972 —	10
979	# 871 —	100
	High Oleate of Lead (see opposite 979(b))	5
980	# 871 —	100
	Soft Mix Asphalt —	10
	Sulphur —	½

No. Improving #971.

981 Sublimate obtained, when camphor is boiled with HNO_3, saponified by potash.

982 Stearate of soda (neutral) in which acetate of amyl has been found, in the hope of making stearate of amyl.

983 Some of solution of 982 precipitated by acetate of lead solution.

984 #972 dissolved in alcohol, for varnish? beautiful.

985 #971 oxydized more, dissolved in alcohol.

Ou.

No 9 improving # 871.

986. Stearic acid in fusil oil, with HCl gas passed through, might make stearate of amyl.

987. # 871 — 100
~~amyl~~ ~~acetate~~ amyl — 4

988 # 871 — 100
acetate of amyl. 10

989. # 871 — 100
guncotton in amyl acetate 5

990 # 871 — 100
guncotton in amyl acetate 10

991 # 871 — 100
Sulphide of antimony 5.

Om

No. Improving # 871.

992. # 871 — 100
Sulphide of antimony 10

993. # 871 — 100
Sugar — 10

994. # 871 — 100
Sugar — 5

995. ~~#871~~ # 871 — 100
Chloride Strontia 5

996. # 871 — 100
Chloride Strontia 10

997. # 871 — 100
Hydro Sulphuret Rubinum 5

998. # 871
Hydro " " 10

Om.

No. 9 infusions # 871.

999. # 871 — 100
Sulphur — 1

1000. # 871 — 100
Sulphur — 2

1001 # 871 — 100
Sulphur — 5

1002 # 871 — 100
Sulphur — 10

1003 # 871 — 100
Sulphur — 20

1004 # 871 — 100
Sulphur — 30.

1005 # 871 - 100 + ammonia phosphate 5
1006 " " " + " " 2
1007 " " " + " " 10

made a very amorphous mass, tough perfect cut, transparent, mass which after wood dried and cracks.

No Improving # 871.

1008 # 871 — 100 + Potassia Sulphuret 2

1009 " " — " + " " ?

1010 Wool is dissolved in K H O solution, one part wool to three of K H O, and oxydised by two parts permanganate pottash. The solution decanted and filtered. CO_2 is passed through to neutralize excess of pottash. Then it is precipitated by acetate of lead.

1011 Camphor dissolved in alcoholic pottash and oxydised by permanganate pottash.

1012 Tartaric acid is melted direct with tri hydrate of alumina.

On.

No. I improving # 971.

1013 I tartrate of aluminum (nutral) made in wet way.

1014. H ypo phosphite (or hypo phosphite of soda has a remarkable effect on carnauba wax, making it softer with nice cut. violent action takes place when heat is run too high.

1015. melted I tartaric acid in dish ~~that~~ had previously had MnNO in it; (but dish was rinsed out) then added chromic acid (chromic acid) after stirring it exploded with bright yellow flame for an instant just like metallic I sodium would in

hot water.
afterward found that the soda had nothing to do with it.
a string dipped in stearic acid at about 150°F and sprinkled with chromic acid burned with a light almost equal to oxygen - hydrogen - calcium light.
might make candles in this way.

a small wire ~~dipped~~ sponge on end of wire, dipped in alcohol and then in solid chromic acid burns. good cigar lighter & ~~later~~ found to be impractical

No. Useful Determinations.

1016 Amount of Lewis lye in 100 cc of solutions of —
1,340° Sp. Gr. at 78°F = 43.10 gm.
Lewis' lye of 1,200 contains 100 gm dry lye in 425 cc of solution.

1017 Amount of Lewis lye required to make neutral stearate of soda =
Stearic acid — 100
Soda — 17
(anhydrous Na_2O) = (12.5)

1018 Amount of Al_2O_3 in standard solution = 7.0594 gm to 100 gm Lewis dry soda.

No. Determinations

1019. Amount acetate of alumina in standard solution ~~= 7.4~~ = 40.7 gm to 100 of dry Lewis' soda.

1020 amount of Trihydrate of alumina in standard solution = 10.766 gm to 100 gm dry Lewis' soda

The percent of Na_2O in neutral stearate of soda = 12.7

Not ½ scratch of regular, –
make splendid musical cylinders
very hard, will probably require
sapphire cutters – cant be filtered
well – molds nicely – only
keenest edge on recorder can
be used on account of hardness,
can track deep, works well as
a thin or thick veneer.
Low melting point, pours low temperature. The cylinder I tried was
filtered.

Edison.

On. May 30th 1889. (129)

No. A hard wax for musical cylinders.

1622 Purified Color Bees Wax 500 gm.
Carnauba (first grade) 400 "
Dry acetate of Alumina 40 "
Cook well to get off acetic acid
Color light Brick red – there
is considerable precipitated
alumina uncombined in
the wax which causes the
material to filter slowly.

Talks very good, noiseless, smooth, hard, inodorous, loud talking, and in fact perfect except the chips wont go through chip box on account of their peculiar nature.

O. M.

No. Musical Cylinder

1023 Carnauba — 500 } 100
Stearic acid, 100 }
Ceresin — 20.

1024. Made same as #671 except Mitchella stearic acid is used which is much harder made very hard and in fact too hard wax.

1025 #1024 softened by bees wax in the proportion 100 of #1024 to 20 bees wax.
very good musical.

No. Preventing Rig from being ~~susceptible~~ in moisture.

1026. It was found that the cylinders made from Regular (#957) were attacted by moisture of the air. This was a very serious matter as records on cylinders became spoiled and the cylinders that were sent out made of this material had to be called back. At the time #957 was introduced it was cool weather and they were not affected, but when the hot moist summer weather came, cylinders exposed to it, were badly corroded on surface.

No. Moisture Proofing Regular.

1027. Oleic acid or rather the oleate of soda formed in the wax was found to be the cause of wax being affected by moisture

1027. The stearic acid we were getting at the time was found not to as good as that bargained for, it contains oleic in considerable quantity, samples were obtained from Mitchell & Co which were very hard and free from oleic.

#871 (Made from Mitchell?) 100

Ceresin 5

This is O.K. absolutely not affected by moisture, can be soaked over night in water without showing it. Talks even better than old Reg, and makes an excellent musical cylinder. Molds O.K. and at lower temperature. Excepted by Mr. Edison as regular.

No.	Water Proofing Regular Wax.	
1028.	# 871 (made from Mitchells Stearic)	100
	Cerasin	10
1029.	# 871 (made from Mitchells Stearic)	100
	Cerasin —	20
1029.	# 871 (made from " ")	100
	Cerasin —	30

Plant having 500 lbs. per day capacity was started ~~and~~ ~~at 9.0~~ for making # 1030.

Does not duplicate Reg.

No Improving 1029.

1030. The idea of this experiment is to see if we can't do away with the expensive acetate of alumina.

1030 Mitchells Stearic Acid — 1000 gm.
Lewis' Lye — 170 "
Precipitated by alum washed and dried.

1031. Mitchells Stearic — 500
Lewis. ley — 40

1032. # 1031 — 100
1030 — 10

1033 # 1031 — 100
1030 — 15

This duplicates #871 (made from Mitchells stearic acid) except no acetate is used in it makes quicker and easier.

On

No.	Improving Regular Wax	
1034	Stearic acid (Mitchells)	400
	Lewis leg —	36
1035	#1034 —	100
	#1030 —	10
1036	#1034 —	100
	#1030 —	15
1037	Stearic (Mitchells)	400
	Lewis leg —	40
1038	#1037 —	100
	#1030 —	10
1039	#1037 —	100
	#1030 —	15

On.

No.			
	Improving Reg.		
1040	Gleam (Mitchells)	—	500
	Lewis' Reg	—	35
1041	# 1040	—	100
	# 1030	—	10
1042	# 1040	—	100
	# 1030	—	15
1043	# 1034	—	100
	# 1030	—	15
	Ceresin	—	5
1044	# 1034	—	100
	# 1030	—	15
	~~Ceresin~~	—	
	Paraffin	—	5

This is an exact duplicate of Reg (1029) and is much cheaper and easier to make. The acetate of alumina being done away with. Suggested by Mr Edison.

On.

No.	Improving Regular Wax	
1045.	# 1034 —	100
	# 1030 —	15
	White Wax —	5
1046.	# 1034 —	100
	# 1030 —	15
	Ceresin —	30
1047.	# 1034 —	100
	# 1030 —	15
	Ceresin —	20
1048.	Metallic Stearate —	100 } 100
	C.P. No 140 —	9
	Ceresin	20
	Stearate Alumina	15.

Om.

Me Improving regular

1049 #1048. — 100
Boiled Cofabia — 10

1050 #1048 — 100
Cofabia Balsam — 5

1051 #1048 — 100
Rosin — 5

See N= 890530 p.43
#1052 No 22
June 13, 1889
Same note.

After standing some time these cracked, that is some of them.

No. Venus Cylinders.

1052 Made for venus cylinders for Wangerman to take to Europe. Strained through heavy filter cloth.

Bees Wax 10395 gms.
Carnauba 8316 "
Dry acetate of alumina
831 gm.
The acetate is added in small lots and well stirred.
Sem not exceeding 500.

Plaster forms and thin shell experiments.
Within #1029 as wax.

#1052 $\frac{1}{2}$.
Cylinders dipped on polished brass mandrill larger size and ~~to~~ smaller taper than ordinary mandrill; the cold mandrill is dipped in the wax (305°F) and left on mandrill until cool, mandrel was oiled with castor oil. the shell of wax came of mandrill and did not crack.

#1052 $\frac{1}{3}$ Dipped in same wax as #1052 $\frac{1}{2}$
Temperature 310°. Oiled mandrill.
Dipped $\frac{1}{4}$ min.
left on mandrill until cool = 1 hr.
temp. of room 79°
b. ~~Wax~~ left on mandrill over night.

#1052 $\frac{1}{4}$ Dipped same as 1052 $\frac{1}{3}$, cooled in cold water, surface of wax scarcely attacked by the H_2O.

#1052 $\frac{1}{5}$ – Temp of wax 320°. temp. of room = 79°
Dipped $\frac{1}{3}$ min. left on mandrill 1 hour.

Idea of above thin shells is that they are used as the out side molds, with a cory inside, in which plaster paris is poured out at bottom shell and cory so as to form a backing for shell. Works good for mass but cracks with thin shells.

No. Making Veneers.

1053 asphalt cylinder is dipped (on brass mandrell) in #1046. at as low a tem. as the wax will stand without forming scum on surface, and hold a length of time which shall depend on the thickness of the veneer wanted.
Veneers can be made $\frac{3}{32}''$ thick in this way.
The asphalt cylinders have to have their surface prepared with some substance such as, rubber bollitta gum, dissolved in some solvent which will evaporate, ~~and make~~ in order to insure the wax to stick. They will not crack when they stick

Too much carbonate would not all dissolve, and made high melting point wax.

Quite good but, not quite enough carbonate.

all O.K. exact duplicate of Reg made other ways and much cheaper and quicker made.

Aug 14/1889,

No. Another Improvement on Reg.

1055. Stearic Acid ~~500~~ 500 gm.
Crystalized Carbonate soda 202.5 gm.

1056 Stearic Acid 500
Carbonate Soda 140

1057 Stearic Acid 500 gm
Carbonate Soda (cryst) 150 gm.
Crystals washed, and powdered in mortar, and added to melted stearic bitts, by little, Melts at 230° F.

1058 #1057 — 100
Stearate Al — 15
Ceresin — 30

No.

1059. It was found, that the washed crystals, can be used in making #1058 without grinding them up, which makes it cheaper yet. The crystals come a $1\frac{1}{2}$¢ per lb., they are picked over and wash those which are dirty dissolved and recrystalized, which is a very small percent.

$1059\frac{1}{2}$ #1058 With stearate Al made in large plant.

No. Determinations.

1060. In making stearate of alumina
To saponify 75 lb. Stearic
acid use 24543 cc Lewis' ley
of specific gravity 1,200°.

No.

1064. For making cylinder mr.
Edison decided to use
hard rubber shell dipped
in Rag wax.
For Venus Music # (of
Substitute for hard rubber
experiments) for base
coated with # 1047

No. Sept 13th 89.

1065 Mitchels Strani — 4000 gm.
Crystals of Carbonate — 1200 "
To duplicate 1059.

1066. #1036 — 100
Petroleum residue (or wax) — 10
Idea being to do away with expensive ceresin. Petroleum wax comes at ¼ ¢/lb.
Makes very polished cut hard cohesive, but scratches on phonograph.

1067. #1036 — 100
Petroleum wax — 20.
Too soft, very polished cut, about 15 to 100 of #1036 will fitch it.

No. Reduction of Stearic from Sept 16 H. 99.
Waste Wax having oleic acid
in it (#957)

1068.

amount of waste wax (#957) = 500 gm.
Dissolved in about two gal. water,
Precipitated by 50 gm SO_3 = 45.4 gm —
of solution of H_2SO_4 at 1200° sp. gr.
Flame was slightly too much H_2SO_4.
Weight of dried precipitated fats = 475 gm
Weight of fat distilled = 428 "

No. Melting points.

No 9. Mitchells Stearic acid melts at $131\frac{1}{2}$ °F
2nd conf —
3rd "
4th "
5th "

(light coloured, not burned)
#105 melts at — — — 236 °F

No. Miscellaneous. Experiments.

1072. Carnauba is distilled in vacuno

a The fat which came ~~the~~ over first, white with tinge of yellow, very much softer than carnauba, but harder than bees wax.

b. Second sample from #1072: about same as a)

c Third sample about the same as a

d. Fourth sample little lighter and harder than c).

#1073. #1059 Made in phonografh works in large kettle (nickled) came out O.K. And on test the cylinders were found to talk even better than others not any crackels, which I think were due to acticacid in old process

No. Music cylinder base.

1074. # 123 of book #569 molded in screw press, in mold fitted with piston. The material is first made and then placed in the mold, the whole heated to about 250°F. and pressed while hot.

Base for Reg + Music Cylinder molding

1075 of wax over base already made.
The cylinder is fitted on to a hollow core having water hose connected so as to keep it cool flowed in a jacketed mold which is kept warm.
Wax poured as usual

1076 Molded in same mold as in #1075 this is cooled this time after the wax has been poured ~~the~~ core was a regular one not cooled.

No. Oct 24th 1889.

1077 #1074 diffed in regular wax
Came out bad had no bubbles
in which came from the compound
in the sub-cylinder
Could not dif over $\frac{3}{64}$ thickness of
wax

1078. #1074 cylinder has a cylinder
of reg wax which has been
diffed on a mandrel the same
size as the outside of the cylinder
diffed over it while the wax
cylinder is yet plastic
works splendid makes a fine
cylinder and they could be
made with $\frac{1}{8}$" thickness of wax.

No.

1079. The mandrel for ~~di~~ffing cylinders to be shrunk on sub cylinders should be 2" diam. straight i.e. no taper, + 5 in long. and should be diffed for one minute in wax at 280° F.

The machine for diffing should run at about 44 revolutions per min.

1090 The sub-cylinder is coated (diffed) in paraffine 100 rosin 100 camauba 5 to make the outside shell stick better, and not crack.

1081 Ozokerite 100
Bees wax 100
Diffed on paper.
Flexible but gums on knife does not mount very good.

1082 N - O e — 175
- - m — 100
- - - n -- 30
H O. a a — 20
a - e a - l — 600
e - n — 300
a l - l — 300

000746

1093 # 1082 dipped on regular cylinder. previously turned off.
no good, wavy + rough, wax surface spoiled.

1094 # 1082 dipped on brass sleeve (polished)
very good, good, talk, some scratch, flexible when torn off could not be removed whole even when heated.

1095 # 1082 poured inside of a glass bottle of proper ~~taper~~ shape is made to revolve throwing stuff in thin film all over inside of bottle, air is passed in to dry.

Bang #, made film collapsable cylinder does not crack when bent double.

#1086 #1092 Diffed on regular cylinder coated with paraffine
no good, paraffine attacked.

1087. #1082 formed on glass plate and intended to be cut in strips width of cylinder and then rolled over lapped while on a standard form.

1088. #1082 Diffed on brass sleeve coated with silicate soda.

1089. #1082 Diffed on wax cylinder coated with silicate soda.

1090. Sheet hard rubber $\frac{1}{100}$ thick is diffed in regular wax at 370°F. after diffing made into cylinder with two leaves hinged together

Did not crack	1100 Cold test on wax cylinders. Soft fuzzy thread, small wax size, twisting in regular ~~cylinder~~ diffed double, cold by solid carbonic acid (-108°F.) 4 of these were tryed, all come good.
Cracked very bad.	1101 Same conditions as 1100 except larger size cord was used.
Cracked bad.	1102 Same conditions, larger size cord coated with balata gum.

Useful Data

By experiment, the stearate of alumina used in the manufacture of wax was found to contain 8.785 % Al_2O_3

Hence, in making the wax, where 17 lb. of stearate of ~~soda~~ alumina are used to 100 lbs. of stearic acid, 1.4875 lbs of Al_2O_3 added to 115½ lb stearic acid would make wax containing same proportion of Al_2O_3,

Or in other figures the proportions for making a charge of wax would be.—

Stearic acid	100 lbs	($C_{18}H_{36}O_2$)
Crystal carbonate soda	29.5 "	($Na_2CO_3 \cdot 10(H_2O)$)
Anhydrous oxide of alumina	1.288 "	(Al_2O_3)
Rosin	20.2 "	

With Aluminate of soda, the formula would be.

Stearic Acid	100 lb.	($C_{18}H_{36}O_2$)
Crystal carbonate soda	18.5 "	($Na_2CO_3 \cdot 10H_2O$)
Aluminate soda	3.618 "	($Al_2O_3 \cdot 3Na_2O$)
Rosin	20.2 "	

Notebook, N-88-08-28

This notebook, which covers the period August-September 1888, is a continuation of N-88-06-10. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. There are notes, tables, drawings, and calculations regarding non-magnetic watches, meters, batteries, alternating current, generators, and transformers. Some of the entries relate to physiological experiments using gasoline on shellfish, insects, and other organisms. Among the experimenters whose work appears in this book are F. P. Bergh, Alex W. Brigham, E. C. Boynton, Johannes H. Cuntz, and T. F. Lawrence. There is an index at the end of the book. The front cover is labeled "Record Book No. 5 Edison Galvanometer Building." The back cover is labeled "517." The spine is labeled "75." The book contains 88 numbered pages. Some pages were removed before the book was paginated. Numerous graphs have been pasted into the book.

The index has been filmed first.

Index.

Alt. Cur. Electrolysis 12, 13, 23, 28-31, 52-55.
Anvil Experiments 48-51.
Boiler + Engine Test 80, 81.
Converter, Multiphase 27.
Determination of λ 2-4.
Earth Plates 64.
Engines Tests 1, 17.
Galvanometers, Constants + Comparison of 36-38, 46.
Gasoline Experiments 60, 66, 67, 70, 71, 85-88.
Motor Tests 5-7, 13, 14, 18-24, 32-35, 40-43, 46-47, 57, 59-66, 72, 73, 78, 82, 83, 86, 87.
Octopolar, Depth of Winding of Bobbins 65.
Pendulum, Period of Oscillation 16.
Phonograph Motor 18, 79, 84.
Physiological Experiments 11.
Resistance between 6" Dynamo + 6" Motor 56.
Resistance Coil, Design of 58.
Storage Cell 39.
Transformers 68, 69, 74-77.
Watch Test 1.
Watch Shield Test 8, 9, 10.
Watch Spring Test 25, 26.

x E-172 N-88-08-28

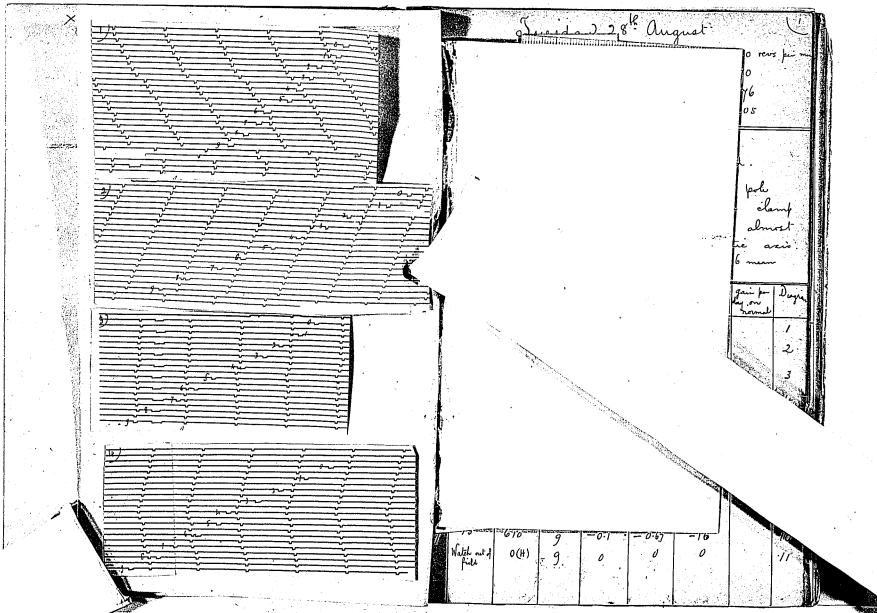
Record Book

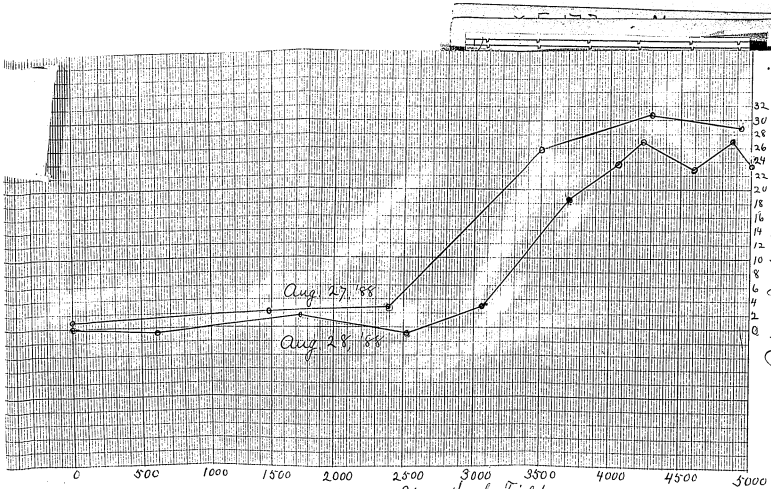
No. 5

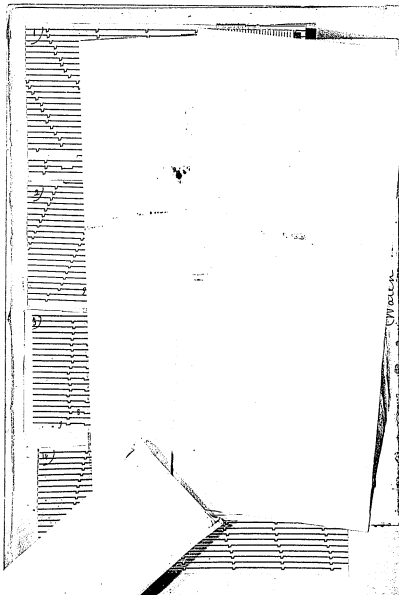
of Observations, Calculations and Data of the Galvanometer Room

Edison Laboratory

Commenced 28th August 1888.


Tuesday 28th August
0 revs per min
0
76
05
pole
clamp
almost
ie axis
6 mean
gain per day or month
Days
1
2
3
6·10
9
−0·1
−0·6
−18
Watch not of field
0(H)
9
0
0
0
11


Aug. 27, '88
Aug. 28, '88
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Strength of Field
in
C. G. S. Units.
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Rate of Variation
in
Seconds per Hour.
Watch No. 1.



Tuesday 28th August

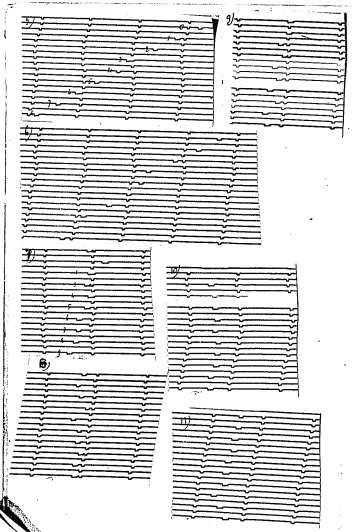
Speed of Arm. Simms Engine 240 revs per min
" " Shafting 370
" " #20 Dynamo 776
" " 130 volt 1405

Trial of rate of #1 Watch in powerful magnetic field, continued.

Pendulum e.mag. vertical. S seeking pole uppermost. #1 Watch dial up held in clamp so that its balance wheel axis almost exactly coincided with magnetic axis.

Thermo Thin. hall. galv. from 0.5# 1 c.c. 118.6 mm

Mean Tem. Galv. Poles	Mean Thermo from Field Calibration	Mean Abs. Mag. Field.	Time of Chronograph Record	Gain in this time	Gain per hour	Gain per day.	Gain per day on normal	Degree
53°.15'	122.6	5000	59	3.5	23.3	559		1
47°.45	119.5	4870	9	4	26.7	641		2
42°.0	112.6	4590	9	3.4	22.7	545		3
36°.45	104	4240	9	4	26.7	641		4
31°.15'	99.5	4060	8	3.15	23.6	566		5
28°.30'	91	3710	9	2.8	18.7	449		6
22°.30'	75.25	3070	9	0.5	3.33	80		7
18°.30'	62	2530	9	−0.1	−0.67	−16		8
12°.30'	42.6	1740	9	+0.25	+1.67	40		9
5°.7'	15	610	9	−0.1	−0.67	−16		10
0	Neither nor Field	0(H)	9	0	0	0		11



Wednesday 29th August

Record of measurements taken for the determination of λ. (Observer Kennelly 26. 8. 98)

Temp. 25°C. 1 std. cell 1.04 Ballistic galvo.

−		+
		243
220.5		
		211
191.7		
		183.6
167		
		159.8
145.7		
		138.3
126.8		
		121
110.5		
		104.9
96.3		
		91.8
83.7		
		79.1
73.6		
		69.5

$$\lambda = \log_e \frac{463.5}{231.5} = \log_e (1.0711) = 0.07114$$

$$\lambda = \frac{1}{4}\log_e \frac{463.5}{79.5} = \frac{\log_e 2.6101}{4} = 0.06926$$

Method of Record

	+ 242
	+ 18.5
− 14	+ 15
	+ 242
	+ 17 (2.5 div early)
	+ 243
	+ 18.5
− 14.3	+ 15
− 13	
	+ 12.5
− 11.5	
	+ 242.5
	+ 19.8
− 14.5	+ 15.5
+ 13	

Repetition of three trials . Observer Mr Lawrence

Temp. 21.2°C. Std. cell 1 t same galv. 29.8.18

Recoil method

	− 237
	− 17.5
	− 236
	− 17
	− 237
	− 17.5
	− 237
	− 17
	− 236
	− 16.8
	− 237.5
	− 18
Temp 21.1°C. 0.5t	− 119
	− 7
	− 118
	− 7.5
	− 117.5
	− 8.5
	− 117
	− 10
	− 118
	− 8.5
	− 118
	− 8.0

16.22 o'clock. Temp. 21.8°C. Decrement Series

14

− 236	+ 222
+ 206	
181	195
158	170.5
139	146
121	131
106	115
92	100.5
81.5	88
71.3	77
63	68
55	59
48	52
42	45.3
	40

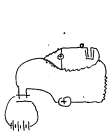
(Thursday) 30th August.

Meter tests.

Took 4 25 light meter bottles. Cleaned the zinc by immersion in dilute H_2SO_4 then amalgamated them in filtered mercury. Then after connecting them in couples immersed them in $ZnSO_4$ pure slightly acid solution of special preparation.

The 1st test was for resistance simply as follows.—

The bottles had a thermometer inserted in each, and were all put in the refrigerator the resistance of each bottle was then observed up to 30 mas. current. The current for 25 lamps might be 15 amps and of this nearly ~~too~~ part going through the bottles would be 15 milliamperes. The subjoined currents are 1% in excess of the currents actually traversing the cells, as a ratio of 100/1 was employed.



The thermometer 74.

Bottle #	Time	R in ml	Current Mins	Bridge Ratio	Res. of gauge	Ratio to Res. 25°	Res. of Bottle	Res. of crude	
1	10·45	6500	1	1000 ~/sec	2.30	0.593	0.5932+4107	1.60	
	10·47	2600	2	-	2.26			1.56	
	·49	1300	3	-	2.26			1.56	
	·51	800	4	-	2.26			1.56	
	·53	500	5	-	2.26			1.56	
	·55	250	6	-	2.25			1.55	
	·56	50	7	-	2.25	2.29		1.55	1.59
Temp. 13.5°	11·05	800	8	1000 ~/sec	2.21	2.26		1.51	1.56
	·07	700	10	-	2.21	2.27		1.51	1.57
	·10	532	12.5	-	2.21	2.26		1.51	1.56
	·14	457	15	-	2.21	2.25		1.51	1.55
	·15	385	17.5	-	2.20	2.23		1.50	1.53
	·30	330	20	-	2.21	2.23		1.51	1.53
	·34	260	25	-	2.19	2.21		1.49	1.51
	··	210	30	-	2.185	2.21		1.485	1.51
2	14.45	6200	1	1000 ~/sec	2.35			1.65	
	·50	2500	2	-	2.33			1.63	
	·52	1300	3	-	2.33			1.63	
	·53	800	4	-	2.33			1.63	
	·54	500	5	-	2.33	2.38		1.63	1.68
	15·00	180	6	-	2.38	2.38		1.68	1.68
	·03	19	7	-	2.33	2.37		1.63	1.67
	·05	895	7	1000 ~/sec	2.31	2.37		1.61	1.67
	·08	775	8	-	2.33	2.37		1.63	1.67
Temp. 12.5°	·10	580	10	-	2.33	2.36		1.63	1.66
	·12	510	12.5	-	2.33	2.36		1.63	1.66
	·14	445	15	-	2.32	2.35		1.62	1.65
	·16	375	17.5	-	2.32	2.35		1.62	1.65
	·18	320	20	-	2.31	2.34		1.61	1.64
	·19	250	25	-	2.30	2.335		1.60	1.635
	·20	200	30	-	2.295	2.33		1.595	1.63

Bottle No.	Time	Res. in ect	Revolutions Mag.	Bridge Ratio	Res. observed.	Mods. L. & S.	Res. of Depth	Res. of C. complete
3	15·22	6200	1	incorrect	2·77		2·07	
	·23	2500	2	-	2·75	2·79	2·05	2·09
	·25	1300	3	-	2·74	2·79	2·04	2·09
	·27	800	4	-	2·71	2·79	2·01	2·09
	·28	540	5	-	2·70	2·74	2·00	2·04
	·29	180	6	-	2·55	2·67	1·85	1·97
	·44	890	7	incorrect	2·51	2·55	1·81	1·85
	·47	860	8	-	2·50	2·54	1·80	1·84
	·49	675	10	-	2·46	2·51	1·76	1·81
	·51	537	12·5	-	2·44	2·49	1·74	1·79
	·53	435	15	-	2·40	2·42	1·70	1·72
	·56	383	17·5	-	2·37	2·43	1·67	1·73
	·59	318	20	-	2·36	2·40	1·76	1·70
	16·07	244	25	-	2·34	2·38	1·64	1·68
	·03	207	20	-	2·33	2·34	1·63	1·66
4	16·06	6050	1	incorrect	2·47	2·56	1·77	1·86
	·08	2450	2	-	2·50	2·56	1·80	1·86
	·10	1280	3	-	2·50	2·58	1·80	1·88
	·11	680	4	-	2·50	2·57	1·80	1·87
	·13	410	5	-	2·49	2·57	1·79	1·87
	·14	165	6	-	2·49	2·57	1·79	1·87
	·16	980	7	incorrect	2·52	2·59	1·82	1·89
	·17	855	8	-	2·51	2·55	1·81	1·88
	·19	676	10	-	2·52	2·57	1·82	1·87
	·21	536	12·50	-	2·50	2·55	1·80	1·85
	·22	438	15	-	2·48	2·52	1·78	1·84
	·24	373	17·5	-	2·45	2·50	1·75	1·80
	·26	319	20	-	2·44	2·48	1·74	1·78
	·28	248	25	-	2·40	2·44	1·70	1·74
	·29	201	30	-	2·38	2·42	1·68	1·72

Temp. 83°

Temp. 83·5

Watch Shield tests.

Took following tests of the shielding effect of two small leather cased sheet iron guards 5.8 cms in diam 1.2 cms + 0.7 cms deep constructed on the Invalids principle. Watch # 3,013,719 Elgin movement steel hair spring was used in this test.

1st Took chronographic rate of watch during 10 mins before exposing it to field. This rate see diagram 1 is apparently just the clock rate within limits of observation. Time 9.25

2nd Watch put in glass left cam movement in guard and guard in field. ^ Summit bar. 59° = 0.81

Watch left in field 10 mins 9.25/59

Field increased by average = 5+2.5 = 2.5 = 100 secs

3rd Watch removed from field and from shield. Rate tested. 9.35/59 0.65 mm

Rate = 0.65/10 = 0.065 per min = 3.9 secs gain per hour.

See diagram #2.

4th Lowest Field. Summer Tam 73°.

Throw 3 ÷ 2 = 1.5

Watch left in field 10 mins 9.45/59 throw 5 ÷ 2 = 100 secs

5th Watch removed from field + shield + kept tested 10. 15/59 125 mm

Rate = 0.8 = 0.08 + per min = +4.8 secs per hour

Watch Shield tests.

Took following tests of the shielding effect of two small leather cased sheet iron guards 5.8 cms in diam 1.2 cms + 0.7 cms deep constructed on the bridge principle.
Watch # 3,013,719 Elgin movement steel hair spring was used in this test.

1st Took chronographic rate of watch during 10 mins before exposing it to field. This rate see diagram 1 is apparently just the clock rate within limits of observation. Time 9 21/25.

2nd Watch put in glass lift cam ~~movement~~ in guard and guard in field. Second hand 5 9° = 0.8r

Watch left in field 10 mins = 5 + 9 25/25 = 2.5 = 100 secs
Field produced by energy

3rd Watch removed from field and from shield. Rate tested 9 25/25 = 0.65 mm

Rate = 0.65/10 = 0.065 per min = 3.9 sec gain per hour.
See diagram #2.

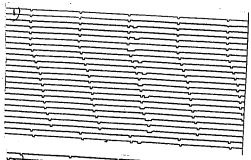
4th Lowered field. Current Tam 73°.
Throw 3 ÷ 2 = 1.5
Watch left in field 10 mins 5 ÷ 2 = 100 secs
Throw

5th Watch removed from field + shield + rate tested 10 15/50 = 0.25 mm

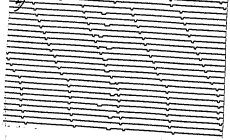
Rate = 0.8 = 0.08 + per min = +4.8 secs per hour

effect
ion guard
deep
pl.
steel
et.
metal
t to field.
quantity
limits of
guard
o.8r
.5 = 100 c.p.s
9.25 0.63
in per hour.
3.
÷ 2 = 100 c.p.s
field 125

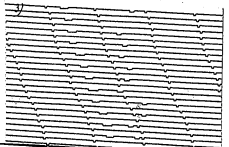
1)



2)



3)



Watch Shield tests.

Took following tests of the shielding effect of two small leather cased sheet iron guards. 5.8 cms in diam. 1.2 cms + 0.7 cms deep constructed on the bristol principle. Watch # 3,073,719 Elgin movement steel hair spring was used in this test.

1st Took chronographic rate of watch during 10 min before exposing it to field. This rate see diagram 1 is apparently just the clock rate within limits of observation. Twice 9.21.

2nd Watch put in guard and guard in field. ^ Second hand 5.9° = 0.8'.

Watch left in field 10 min 9.$\frac{29}{31}$

Field produced by energy = 5÷2 = 2.5 = $\frac{200}{\text{cms}}$

3rd Watch removed from field and from shield. Rate tested. 9.$\frac{29}{31}$ $\frac{\text{#63}}{\text{min}}$

Rate = $\frac{0.65}{10}$ = 0.065' per min = 3.9 sec gain per hour.

See diagram #2.

4th Increased Field. Reversing Tam. 7.3°.

Throw 3÷2 = 1.5

Watch left in field 10 min 10.$\frac{\text{sec}}{\text{min}}$ throw 5÷2 = $\frac{100 \text{ cms}}{\text{min}}$

5th Watch removed from field + shield $\frac{125}{\text{min}}$

+ rate tested 10.$\frac{4}{50}$.

Rate = $\frac{0.8}{10}$ = 0.08 + per min = +4.8 gain per hour.

See diagram #3.

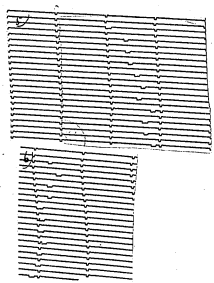
5th Increased field. Rising tam. 8°.15'

Throw 9÷2 = 4

Watch left in field increased 10 min 10.$\frac{29}{33}$

Throw 15.5÷2 = 7.75 watch in field = $\frac{310}{\text{min}}$ cms

Watch stopped. How + min hands did not work after



6th. 10.54 Watch removed from field shield.
Rate checked = Gain 168·0 sec = 0·05 per min
= 1400 sec per hour.
Watch located by compass needle + found to be distinctly magnetic + more so than shield. See diagram ⅔.

7th Watch rate being now hopelessly affected.
Tested the protective power of a similar new shield alone, measuring with the field searcher the throw outside + inside.

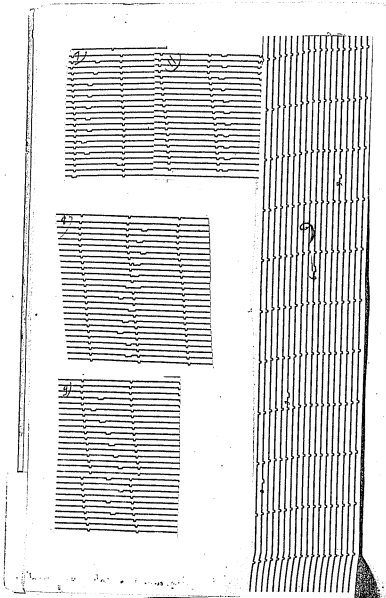
11·20 Def. 46° Summer Tem. Throw outside shield
2 ÷ 2 = 1
Inside shield Throw 3·0
2 ÷ 2.

·25 Def. 59° Summer Tem.
Throw outside 4 ÷ 2 = 2
Inside shield 3 ÷ 2 = 1.5 6·3

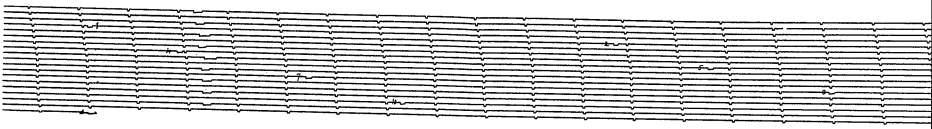
·32 Def. 73°. Summer Tem.
Throw outside 5·5 ÷ 2 = 2·75
Throw inside 3·5 ÷ 2 = 1·75 12·6

·44 Def. 8°·15' Ring Lane
Throw outside 10 ÷ 2 = 5
Inside 8 ÷ 2 = 4 31·5

8th 12·15 Tried watch rate again before demagnetising it.
Loss in ten min 0·9 sec = 5·4 sec. per hour
Evidently after running for a few hours the watch had changed its rate from rapid gain to a slight loss.



9 10 Watch now demagnetised by exposure (10)
15.15 to field of solenoid carrying alternating current
15.29. Watch exposed to field again.
Current 46° Sunrise Tan.
Throw in the field 3.25? ÷ 2 = 1.63
16.00 Watch removed from field.
Rate 0.5 gain in 10 min = 3.0 secs per hour. #6.
16.$\frac{12}{20}$ Watch again exposed to magnetic field
Current 57° Sunrise Tan.
Throw in the field $\frac{2+5+4}{3}$ ÷ 2 = 3.7 ÷ 2 = 1.85
16.23 Rate compared.
Gain 0.6 in 10 min = 3.6 secs per hour. #7
16.$\frac{37}{47}$ Watch again exposed to field
Watch stopped
Current 73° Sunrise Tan.
Throw $\frac{4+6}{2}$ = 5 ÷ 2 = 2.5
16.47 Watch removed + rate taken.
$\frac{16.50}{17.00}$ Rate 0.6 in 10 min = 3.6 secs per hour #8
17.$\frac{00}{14}$ Watch again exposed to field
Watch stopped.
Ring galv. 8.15
Throw 13 ÷ 2 = 6.5
17.$\frac{15}{25}$ Rate compared
Loss 0.25 secs in 10 min = 1.5 secs per hour
See diagram #9.
17.32 Watch again exposed to field
Ring galv. 15
Throw 25 ÷ 2 = 12.5
17.$\frac{45}{55}$ Rate compared
Gain 234 secs in 366 = 2300 + per hour. #10
17.58 Demagnetised watch by altg. current + rate. Then normal #11



Thursday 30th August

Physiological Experiments cont.

82. Brown setter mongrel bitch W. 33
L. 32
H. 20
Res. 11,000ω
Res. not stable
pulsation 160

20.50.

21.00 Direct current. Municipal Machine
Contact 60 secs:
Voltage 46° = 69 × 4 = 276 volts.
Dog howled and struggled until last second or two. Current 0.4 amperes increasing to 0.45.

21.01 Current off. Dog dead.
It is probable that 10 secs. less current would have saved it.
Res. after death 74,000. polarizing to 780ω.

---

82 Small black terrier bitch W. 10 lbs
L 18
H 12
Res 9700

Alternating current 60° = 82 × 7 = 574 × 1.4 = 517
300 alternations per sec:
Contact made for about one second.
Dog died immediately. A few gasps immediately after.
Res: after death 8000.

Friday 1st September.

Experiments with alternating current.

Prepared 3 voltameters as follows—

1 Drain wire 0·0035"
Length 0·23" + 0·74"

2 Drain wire 0·002"
Length 0·34" + 0·5"

3 Drain wire 0·002"
Length 0·16" + 0·17".

16·02 Alternating current turned on.
Voltmeter reading 85v = 104 − 10·4 = 93·6 volts.
through all three voltameters in series.
Three approximately equal batteries were supported over them. The solution was the same in each.

10·15. # 2 had 10 c.c. mixed gas $1·67 \times 10^{-5}$
9·30 # 3 - - - - $2·24 \times 10^{-5}$
13·00 # 1 - 8·6 - - $4·42 \times 10^{-5}$

3 took therefore 450 secs. for 10 c.c.
2 - " 495 - - 10 -
1 - " 660 - - 8·6 -

Friday 1st September.

Meter tests.

Temperature effect.

Employed the same four bottles but owing to the fracture of #3 it had to be omitted from the series. These bottles were put in the refrigerator and ice packed round them. The temperature was at first observed by means of a thermometer in each, but subsequently there appeared so much discrepancy between different ~~other~~ thermometers that only one our standard was read and the other temperatures were assumed to be the same at the same time. The thermometer was inserted through the glass stopper with its bulb half way up the liquid.

The res. is from the following table obviously higher at a lower temperature.

The current was after a few preliminary trial maintained at 0.99 × 10 mec.

The readings were taken both to true and false-zero.

After the test was complete, and it lasted from Friday morning to Saturday morning, the plates were taken out + reamalgamated after cleaning

10 mins. Motor temp held between 2.7° + 37.7°C.

Photograph	Time	Temp °C	Temp °F	Pressure cat	Bottle #1 f.z.	Bottle #1 L.z.	Bottle #2 f.z.	Bottle #2 L.z.	Bottle #4 f.z.	Bottle #4 L.z.
1	10.43	3.8	39°	700	2.64	2.74	3.68	3.74	3.87	3.91
2	11.15	2.7	37°	700	2.75	2.80	3.74	3.80	3.83	3.88
3	11.40	3.0	37½°	.	2.77	2.84	3.79	3.84	3.75	3.86
4	13.03	4.4	40°	.	2.65	2.71	3.70	3.75		3.81
5	13.27	6.1	43°	.	2.70	2.80	3.75	3.55	3.65	3.45
6	13.52	8.0	46½	.	2.76	2.55	3.57	3.27	3.43	3.22
7	14.34	12.2	54	.	2.38	2.23	3.07	2.85	2.95	2.75
8	15.10	15.0	59	.	2.24	2.07	2.73	2.52	2.77	2.49
9	15.29	16.4	61½	.	1.64	1.64	2.40	2.40	2.43	2.40
10	16.24	18.3	65	710	1.87	1.85	2.74	2.33	2.45	2.32
11	16.47	19.4	67		1.97	1.95	2.52	2.30		
12	17.05	20.5	69		1.87	1.80	2.27	2.17	2.22	2.10
13	17.33	22.5	72½		1.81	1.50	2.25	1.90	2.11	1.95
14	18.30	25.5	78°		1.68	1.68	1.97	1.80	1.97	1.80
15	19.11 9.23	25.5	78°		1.61	1.65	1.83	1.87	1.69	1.74
16	9.38	27.5	81½		1.53	1.57	1.67	1.77	1.56	1.57
17	9.46	28.8	84°		1.47	1.50	1.70	1.74	1.49	1.51
18	9.58	31.1	88°		1.40	1.43	1.59	1.55	1.40	1.42
19	10.07	33.3	92		1.34	1.38	1.44	1.48	1.28	1.30
20	10.23	36.1	97		1.25	1.29	1.21	1.34	1.21	1.24
21	10.32	37.5	99½		1.28	1.25	1.27	1.20	1.18	1.20

Saturday 1st September.

Alternating current experiments. with 3 Voltameters prepared as follows

10% Sol. H_2SO_4 c.p. Platinum wire

#1	0.003" diam.	length 0.76"
	0.003"	0.33"
#2	0.0020	0.50"
	0.0028"	0.18"
#3	0.001"	0.70
	0.001"	0.22

Same conditions as heretofore viz Condenser in cct. with alty. current machine and 3 voltameters in series the Bardew being on the terminals of the leads from ens: n:

10.40.00 Current on. Bardew 88° = 105 volts.
L −10.5
94.5 - mean

47.30 #1 filled 4 cc. after 450 sec.

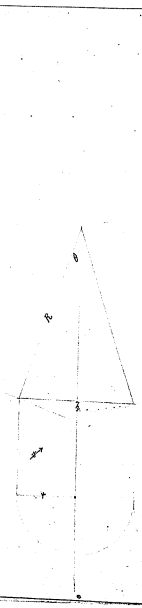
47.30 #2 " 9 " " " 450 "

47.00 #3 " 10 " " " 420 "

Made 3 voltameters of wire same diam 0.001 as follows

#1	length 0.42"	Bardew 83° = 101	
	0.23"	10	
		91 volt mean	
#2	" 0.72"	It was noticed that #1	
	0.52"	which liberated most rapidly	
#3	" 0.70"	appeared to form a plate of	
	0.22"	iron apparently by ordinary	

#1 filled 10 c.c. in 405 sec on reversing over the interval
#2 " " " " 465 " of the second. #2 did so
#3 " " " " 525 " to a slight extent but in #3 it was hardly noticeable



Sunday 2nd September

Investigation of the exact period of oscillation of a pendulum as compared with the approximate period given in text books as $T = 2\pi\sqrt{\frac{R}{g}}$.

Let m be the bob's mass
" h " its perpendicular ascent
" R " radius of movement
" θ " angle of deflection.

The energy acquired in virtue of the ascent h is mgh and if there be no friction this equals the kinetic energy $\frac{mv^2}{2}$ at the lowest point whence $v = \sqrt{2gh}$ and this must be the velocity in the equivalent orbit. The original velocity of ascent from the deflecting impulse must also have been $v = R\Omega$ where Ω is the $\frac{d\theta}{dt}$ at time 0.

Consequently equating the energy in the circle R and that in h we have $\frac{1}{2} m R^2\Omega^2 = \frac{m}{2} r^2\omega^2$ where $\omega = \frac{2\pi\sqrt{g}}{T}$

$$= \frac{4\pi^2 r^2 m}{2\, T^2}$$

$$= \frac{2\pi^2 r^2 m}{T^2}$$

but from the theory of the pendulum, we know that $v^2 = R\Omega^2$

$$= \frac{g}{R} r^2 \cos^2\theta$$

$$\therefore \frac{g r^2 m}{2R \cos^2\theta} = \frac{2\pi^2 r^2 m}{T^2}$$

$$T = 2\pi \cos\theta \sqrt{\frac{R}{g}}$$

and when θ is small this takes the usual form

This is only a second approximation to what can only be expressed by an infinite series.

Diagram from ..... Engine at .....
Diameter of Cylinder ..... ; Diameter of Rod ..... ; Stroke ..... ; Clear
Date ..... 188 ; Time ..... ; End of Cylinder ..... ; Scale of Sp
Boiler Gauge 60 ; Vacuum Gauge ..... ; Rev. per minute

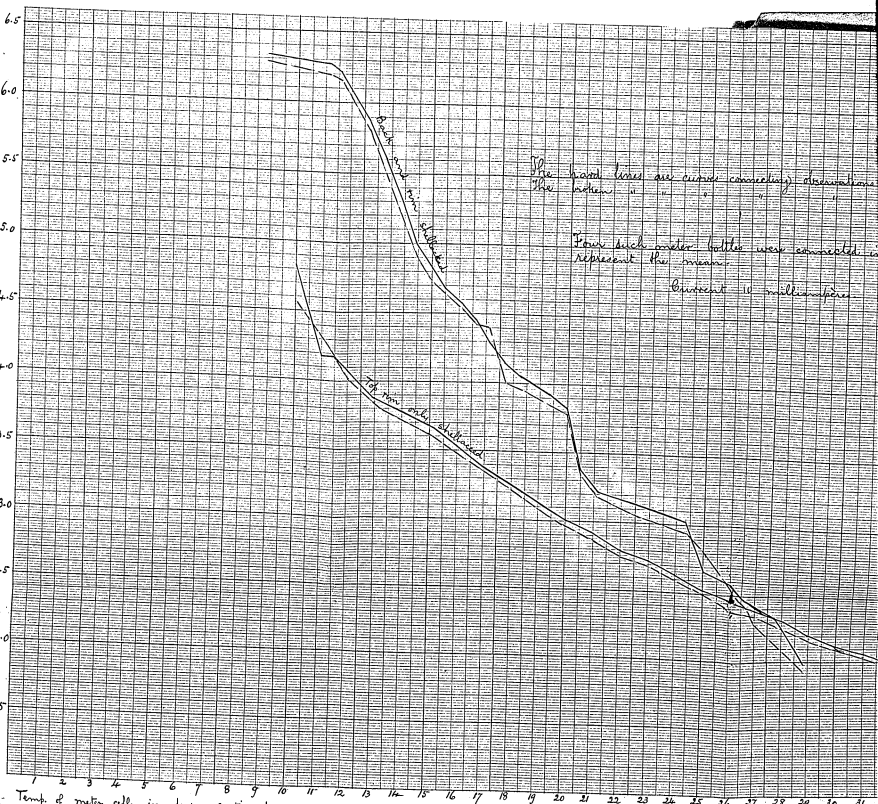
B

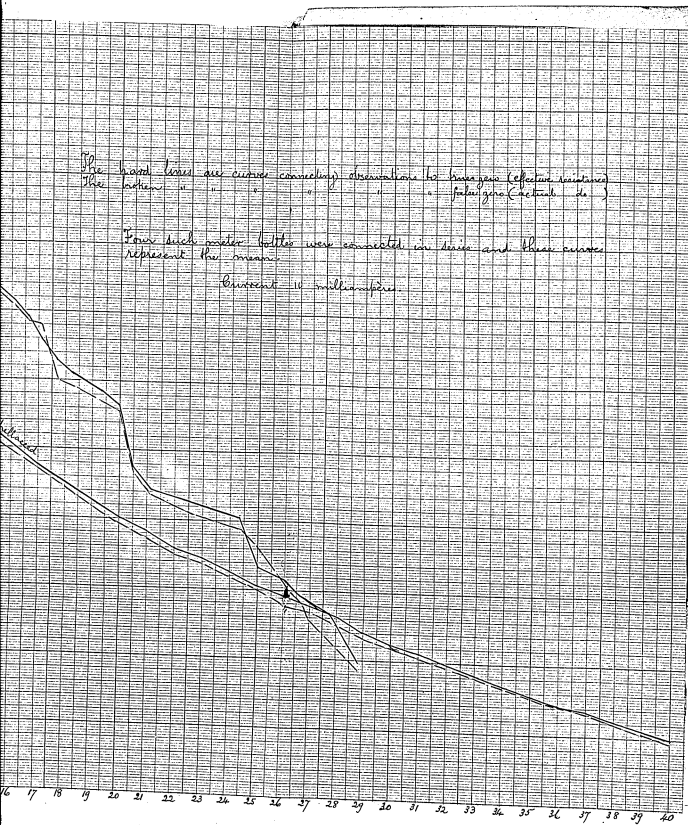
Diagram from ..... Engine at .....
Diameter of Cylinder ..... ; Diameter of Rod ..... ; Stroke ..... ; Clea
Date ..... 188 ; Time ..... ; End of Cylinder ..... ; Scale of S
Boiler Gauge 60 ; Vacuum Gauge ..... ; Rev. per minu

F

Indicator Diagrams of Phonograph Factory (17)
Engine. taken Friday 1st September

Particulars of engine
Diam: of Cylinder 16"
Area . piston 201.06 sq. in.
Diam: piston rod 2½"
Area of do. 4.9 sq. in.
Stroke 3'. 6".
Revolutions per min 85
Back Constant $\frac{201.06 \times 3.5}{33,000} = 2.132 \times 10^{-2}$
Front Constant $\frac{196.16 \times 3.5}{33,000} = 2.08 \times 10^{-2}$
$2.132 \times 85 = 1.81$
$2.08 \times 85 = 1.77$
Back end of Cylinder . Spring 30
Boiler gauge 60 . Revs: 85.
Mean pressure 3.7 lbs.
I. H.P. 6.7
Front end of Cylinder . Spring 40
Boiler gauge 60.
Mean pressure 5.3 lbs. 9.4
Total I. H. P. 16.1


The hard lines are curves connecting observations
The medium " " " " " "
Four inch under bottle were connected in
represent the mean
Current 10 milliamperes
Back and forth soldered
Top from rods soldered
Ohms. Resistance
Temp. of meter cell in degrees antigrade.


The north lines are curves connecting observations to Imagaw (effective resistance)
The other " " "

6.5

6.0

5.5

5.0

4.5

Monday 3rd September.

Trials of New Phonograph motors.

11.20 Used smaller sized Grenet cell

#18 solution 5% zinc.

Revolutions of new model 136 per min. full speed

Condition	Revs. per min	P.D. in terminals	Mean Amps	Amperes	Watts.
Running light	136	1.556	0.31		
Turning off 1/16 each	132	1.542	0.335		
Turning off 1/8 each	126	1.530	0.355		
Motor #2					
Running light	132	1.632	0.30		
Turning off 1/16 each	128	1.604	0.325		
Turning off 1/8 each	128	1.602	0.34		

Measured EMF and Rs of two Hussey cell.

new EMF 1.42 volts

I.R. 0.35 ω

	Res. from cells	
F.Z.	T.Z.	F.Z.
1.83	2.070	1.83
2.21	2.49	2.52
2.22	2.50	2.33
2.24	2.50	2.33
2.26	2.50	2.32
2.27	2.52	2.35
2.28	2.52	2.35
2.28	2.52	2.35
2.29	2.52	2.35
2.28	2.51	2.34
2.26	2.48	2.31
2.23	2.46	2.20
2.19	2.40	2.20
2.16	2.36	2.20
2.10	2.31	2.14
2.00	2.22	2.05
1.95	2.13	1.98
1.85	2.06	1.89
1.77	1.97	1.80
1.66	1.84	1.69
1.57	1.76	1.60
1.50	1.68	1.51

Meter Experiments cont'd.

(19)

Took res: of four bottles separately with 99 mm.

Time	Temp bottles	Temp air	Temp Bridge	Res Bottle 1	Res of #2	Res #3	Res #4	Res in cat.
8.16	23°C	22.7°C	22°C	f.z. 7.99ω Z. 2.00ω	2.00ω 2.02ω	7.95ω 1.95ω	1.95ω 1.95ω	47ω

Res: of these commenced at 2.33ω and fell steadily to above. Connected these to cells in series. Res. leads 0.67ω

Bridge Ratio 100/1

Time	Res. in cat	Mag:	Temp Bridge	Temp of bottles	Res. lead	Res. to f.z.	d. res leads	Res to f.z.	d. res leads
8.30	40	100	22°C	23°C	0.67	7.97ω	7.3	8.00ω	7.33
.35	7100	1				9.50ω	8.83	10.75ω	10.08
.37	3450	2				9.55	8.88	10.00ω	9.33
.40	2250	3				9.63	8.96	10.00	9.33
.42	1750	4				9.69	9.02	9.98	9.31
.44	1450	5				9.73	9.06	10.06	9.39
.46	1255	6				9.80	9.13	10.06	9.39
.47	1090	7				9.80	9.13	10.07	9.40
.49	875	8				9.81	9.14	10.07	9.40
.51	690	10				9.80	9.13	10.03	9.36
.53	440	15				9.70	9.03	9.92	9.25
.55	315	20				9.58	8.91	9.75	9.18
.58	247	25				9.48	8.81	9.61	8.94
9.00	200	30				9.29	8.62	9.45	8.78
.02	145	40				9.05	8.38	9.22	8.55
.06	117	50				8.68	8.01	8.86	8.19
.07	94	60				8.47	7.80	8.60	7.93
.09	65	80				8.08	7.41	8.23	7.56
.10	45	100				7.75	7.07	7.88	7.21
.12	23	150				7.30	6.62	7.43	6.76
.13	11	200				6.93	6.26	7.05	6.38
.15	4	250				6.60	5.97	6.72	6.05

Meter Tests continued.

Temp. test 4 cells in series.
Set cells bottle in mixture of ice and salt and brought the temp. of their solution down to 0°C but this had risen to 1·10°C before connection could be made.

	F.Z. One Cell	T.Z One Cell
	4.57	4.85
	4.31	4.18
	4.18	4.18
	4.11	4.08
	3.84	3.87
	3.72	3.78
	3.62	3.68
	3.48	3.53
	3.36	3.38
	3.22	3.26
	3.08	3.13
	2.97	3.01
	2.87	2.92
	2.75	2.79
	2.68	2.72
	2.60	2.64
	2.50	2.53
	2.39	2.46
	2.34	2.39
	2.25	2.31
	2.16	2.20
	2.09	2.12
	2.03	2.06
	1.96	1.98
	1.90	1.91
	1.83	1.85
	1.77	1.78
	1.68	1.72
	1.62	1.68
	1.60	1.61
	1.53	1.54
	1.48	1.50

Time	T.B.	Bridge Ratio	Res. in ects	Mod	Mod.	Temp. cell	Res. F.Z.	Res. T.Z.	Leads	F.Z	T.Z.
13.56	22.70	1000/10	690	10	Radio	10°C	18.75ω	18.00ω	0.67ω	18.08	17.33
14.00				10		11	17.90	17.40		17.23	16.73
·02				15		11.5	17.20	17.40		16.53	16.73
·05						12	16.70	17.00		16.03	16.33
·08						13	16.02	16.13		15.35	15.46
·10						14	15.55	15.80		14.88	15.13
·12						15	15.17	15.37		14.50	14.70
·14						16	14.60	14.80		13.93	14.13
·16						17	14.10	14.20		13.43	13.53
·19						18	13.55	13.70		12.88	13.03
·21						19	13.00	13.20		12.33	12.53
·23						20	12.55	12.72		11.88	12.05
·25						21	12.14	12.34		11.47	11.67
·27						22	11.67	11.94		11.00	11.17
·29						23	11.38	11.55		10.71	10.88
·31						24	11.08	11.23		10.41	10.56
·33						25	10.65	10.80		9.98	10.13
·35						26	10.22	10.32		9.55	9.65
·37			700		Resonance	27	10.03	10.23		9.36	9.56
·40						28	9.65	9.90		8.98	9.23
·42						29	9.30	9.47		8.63	8.80
·45						30	9.01	9.16		8.34	8.49
·49						31	8.77	8.92		8.10	8.25
·51						32	8.50	8.60		7.83	7.93
·54						33	8.25	8.32		7.58	7.65
·56						34	7.97	8.05		7.30	7.38
·59						35	7.74	7.80		7.07	7.13
15.01						36	7.52	7.56		6.85	6.89
·04						37	7.31	7.36		6.64	6.71
·07						38	7.05	7.12		6.38	6.45
·11						39	6.80	6.88		6.13	6.21
·14						40	6.60	6.65		5.93	5.98

The area of the exposed surface on one of these 25 light plates is

			sq. cm.
	$2 \times 2.5 \times 7.6$	=	38
+	$2 \times 7.6 \times 0.6$		9.12
+	$1 \times 2.5 \times 0.6$		1.5
	Total.		48.62

Thinking that most of this surface was called into comparatively small activity, shelled the rim and outer faces of all the 8 plates and replaced them, thus leaving just 19 sq. cms. of surface or reducing the area 2.5 times.

F. Z. Cm. Cell	T. Z. Cm. Cell
4.83	5.08
4.77	4.96
4.66	4.91
4.65	4.82
4.50	4.66
4.42	4.58
4.26	4.67
4.16	4.33
4.26	4.11
4.03	4.13
3.53	3.63
3.31	3.47
3.11	3.21
2.91	2.96
2.68	2.73
2.53	2.60
2.41	2.46
2.25	2.30
2.14	2.20
1.99	2.05
1.89	1.94
1.80	1.86

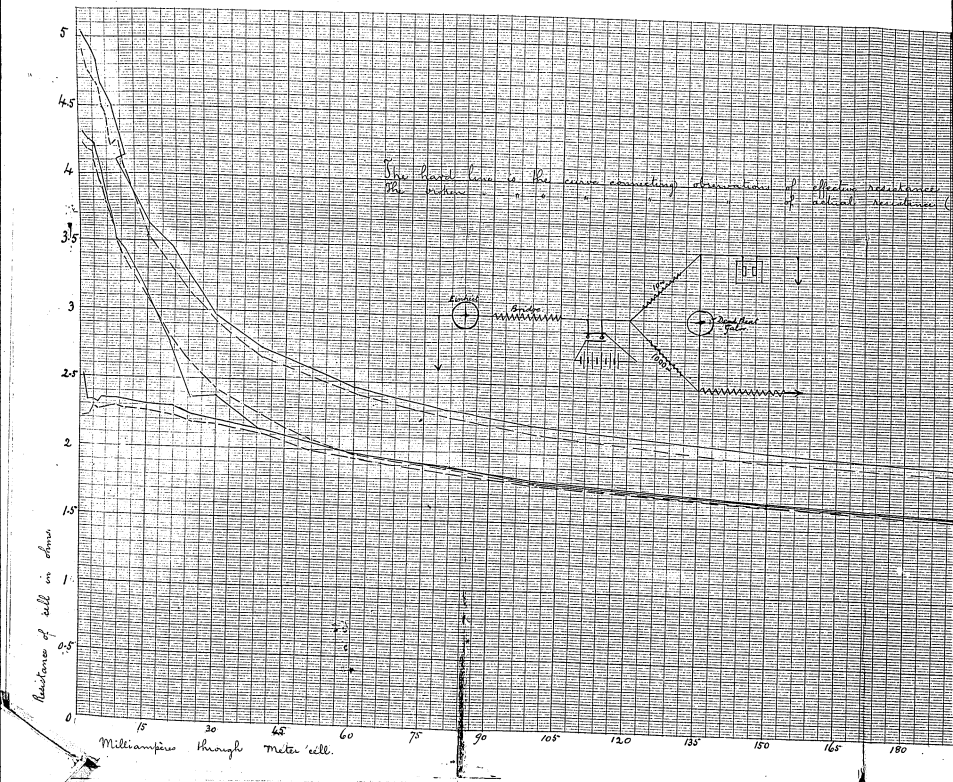
Time	T. Cell	Ratio Body	Resist. cel.	Mes.	Discg. Key F.Z.	T.Z.	Leads	F Z.	T. Z.	Ratio to Leads
6.30	21.5°	1000/10	7300	1	24.00	24.80	0.67	19.33	20.13	
.33			3570	2	19.75	20.50		19.08	19.83	
.35			2260	3	19.45	20.30		18.78	19.63	
.37			1710	4	19.25	19.95		18.58	19.28	
.40			1450	5	18.65	19.20		17.98	18.63	
.42			1185	6	18.35	19.00		17.68	18.33	
.44			995	7	17.70	18.35		17.03	17.68	
.46			1000	7	17.30	18.00		16.63	17.33	
.47			880	8	17.70	17.10		17.03	16.43	
.48	22.		680	10	16.80	17.20	–	16.13	16.53	
.49			440	15	16.80	15.20		16.13	14.53	
.51			311	20	13.90	14.35		13.23	13.78	
.52			240	25	13.10	13.52		12.43	12.85	
.55			192	30	12.30	12.50		11.63	11.83	
7.00			150	40	11.37	11.60		10.70	10.93	
.02			114	50	10.80	11.05		10.13	10.38	
.03			92	60	10.30	10.50		9.63	9.83	
.05			62	80	9.65	9.88		8.98	9.21	
.06			44	100	9.22	9.42		8.55	8.81	
.08			21	150	8.64	8.85		7.97	8.18	
.09			10	200	8.21	8.44		7.54	7.77	
.10			3	250	7.85	8.10		7.18	7.43	

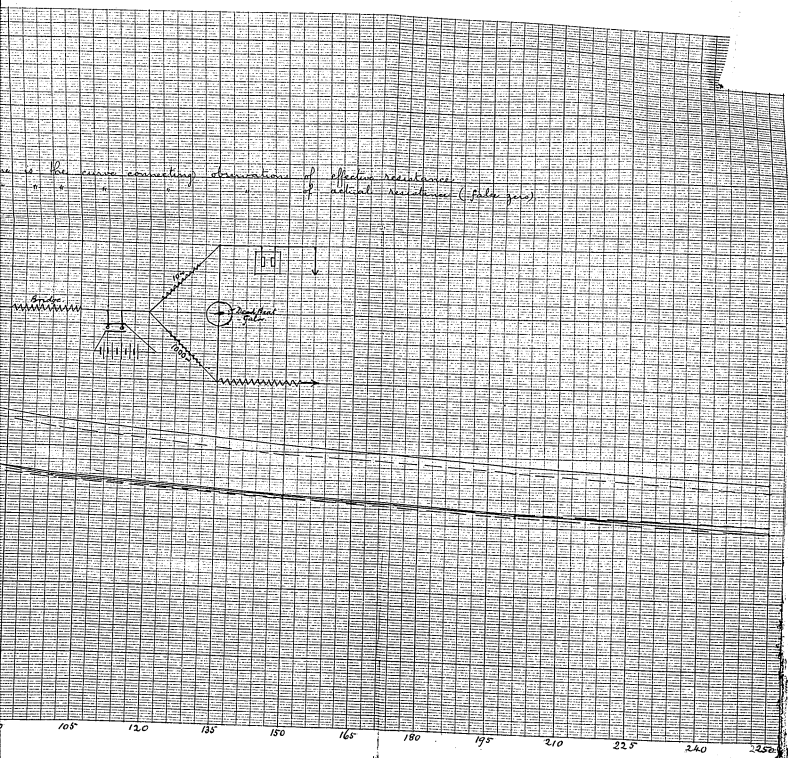
Cons. Coll. F. 2.	Cons. Coll. T. 2.
6.28	6.33
6.20	6.28
6.15	6.22
5.80	5.88
5.44	5.60
5.19	5.29
4.90	5.00
4.73	4.83
4.65	4.68
4.53	4.58
4.42	4.46
4.40	4.28
4.00	4.13
3.76	4.05
3.86	3.93
3.79	3.83
3.23	3.38
3.18	3.23
3.08	3.12
2.95	3.03
2.80	2.67
2.51	2.56
2.48	2.46
2.28	2.32
1.93	1.98

Temperature test.
L^18 Sept: 1888

L bottles in series as before each plate 19, sp. cons.

Time	T.B.	Bright Rate	Res. in cat.	Mar.	Temp. (Cat)	Res. F.2.	Res. T.2.	Leak	Res. F.2.	Res. T.2.	Rate
10.20		100%/10	7.30	10	8.8°C	25.20	25.40	0.09	25.11	25.31	
.22				8	11.10	26.90	25.20		26.81	25.11	
.30					11.6	24.70	24.95		24.61	24.86	
.36					12.7	23.30	23.60		23.31	23.51	
.45					13.3	21.85	22.50		21.76	22.41	
.55					13.8	20.85	21.25		20.75	21.16	
10.08					14.4	19.69	20.10		19.60	20.01	
.18					15.0	19.00	19.39		18.91	19.30	
.25					15.5	18.47	18.82		18.38	18.73	
.30					16.1	18.20	18.40		18.11	18.31	
.43					16.6	17.77	17.92		17.68	17.83	
.51					17.2	16.76	17.22		16.61	17.13	
11.00					17.7	16.65	17.17	0.04	15.98	16.50	
.02					18.3	16.30	16.85		15.83	16.18	
.05					[illegible]						
					19.4	16.05	16.40		15.38	15.73	
.10					20.0	15.82	15.97		15.15	15.30	
.20					20.5	14.00	14.17		13.33	13.50	
.23					21.1	13.40	13.50		12.73	12.87	
.26					22.7	12.84	13.15		12.77	12.48	
.32					24.4	12.60	12.77		11.78	12.10	
.43					25.0	11.90	11.35		11.23	10.68	
.50					24.1	10.90	10.90		10.03	10.23	
.53					26.6	10.30	10.50		9.63	9.83	
.58					27.7	9.60	9.99		9.13	9.32	
12.02					28.8	8.40	8.60		7.73	7.93	


The heavy line is the curve connecting observations of effective resistance
The other " " " " " of actual resistance
Battery
Bridge
Dead beat galv.
Resistance of cell in ohms
Milliamperes through Meter cell.
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
15
30
45
60
75
90
105
120
135
150
165
180



Alternat

Monday 3rd Septem

3 Voltameter

Rough measurem

No.	Time	Diam. wire inches	Diam. de. cms	
I	9.20–9.50 30 hours	0.001 0.001	0.0025 0.0025	
II	9.21–9.51 30 hours	0.001 0.001	0.0025 0.0025	
III	9.21–9.51 30 hours	0.001 0.001	0.0025 0.0025	

The quantity

$2 n E_{max} k^t \times 10^{-7}$

where n = n

E = "

k =

Each of decomposes

$= 1.039 \times 10^{-4} \times 1.$

that means el

∴ the formula be

$V = 3.456$

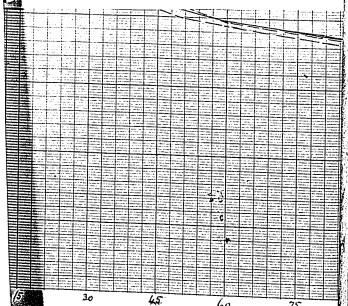
$= 3.456 \times$

$= 5.43 E$

$5.43 \times 2.84 =$

$15.42 \times 1.933 =$

$5.43 \times 2.675 =$



Through Meter cell.

Monday 3rd September

3 Voltameter in series as in last test.
(Rough measurement of volume only)

No.	Time	Diam. with tube	Diam. de. cm.	Length tube	Length cm.	Area Cathode	Vol. gas c.c.	Effect. Resistance	alt. per sec.	Volts	Amps
I	9.21–9.30 360 sec	0.001 0.001	0.0025 0.0025	0.042 0.042	0.602 0.602	83×10^{-5} 47×10^{-5}	10.5	1450	193.3	105	B
II	9.21–9.27 360 sec	0.001 0.001	0.0025 0.0025	0.53 0.76	1.23 1.91	1.3×10^{-3} 1.09×10^{-3} 1.20×10^{-3}	9.0	-	-	-	B
III	9.21–9.27 360 sec	0.001 0.001	0.0025 0.0025	0.22 0.64	0.58 0.60	2.54×10^{-3} 2.33×10^{-3} 2.43×10^{-3}	9.5	-	-	-	B

The quantity passing through the circuit is

$2\,n\,E_m\,kt \times 10^{-7}$ abs. qs.

where n = no. of alternations per sec. Here 193.3

E = maximum voltage 105

k = capacity in microfarads 2.96

Each of decomposes 0.0001038 gramme H.

$= 1.037 \times 10^{-4} \times 1.11 \times 10^{4}$ c.c. $= 1.1522$ c.c. at 0° H

that means also half as much O $= 0.5764$ " " 0° O

mixed gases 1.7983 " "

∴ the formula becomes

$V = 3.456\, n\, E_m\, kt \times 10^{-7}$

$= 3.456 \times 1.5708 \times n\, E_m\, kt \times 10^{-7}$ c.c.

$= 5.43\, E_m\, nkt \times 10^{-7}$ c.c.

$5.43 \times 2.84 = 15.42$ Constant

$15.42 \times 1.938 = 29.81$

$5.43 \times 2.675 = 14.53$

	F.Z. One Cell	T.Z. One Cell
1	4.28	4.31
2	4.18	4.26
3	4.16	4.21
4	4.03	4.11
5	3.91	4.01
6	3.78	3.81
8	3.63	3.71
8	3.51	3.51
10	3.37	3.43
15	3.10	3.13
20	2.80	2.76
25	2.62	2.86
30	2.43	2.38
40	2.25	2.13
50	2.08	2.02
60	1.97	1.99
80	1.88	1.86
100	1.78	1.79
150	1.67	1.68
[illegible]	1.60	1.59
210	1.55	1.55

Meter tests Continued

4th September 1888.

Scraped off the shellac varnish from the edge of the plates increasing area of surface on each to 29.6 sq. cms, and repeated current test as follows:— 4 cells in series

Time	T.B.	Bridge Ratio	T. cells	Res. in ohms	Mec.	F.Z. Ext.	T.Z. Ext.	Leads	F.Z.	T.Z.
15.57	25.6	100/p.	25.5°C	7350	1	17.60	17.90	0.67	16.93	17.23
16.00				3580	2	17.40	17.70	1.	16.73	17.03
16.03				2300	3	17.30	17.50	"	16.63	16.83
16.07				1700	4	16.80	17.10	"	16.13	16.43
16.09				1450	5	16.30	16.70	"	15.63	16.03
16.11				1203	6	15.70	15.90	"	15.03	15.23
16.15				1030	7	15.20	15.50	"	14.53	14.83
16.17				895	8	14.70	14.70	"	14.03	14.03
16.20				695	10	14.15	14.40	"	13.48	13.73
16.38				450	15	13.05	13.20	"	12.38	12.53
16.45				325	20	11.85	11.70	"	11.18	11.03
16.52				250	25	11.05	10.10	"	10.45	9.43
16.55				202	30	10.40	10.17	"	9.73	9.50
16.58				140	40	9.65	9.20	"	8.91	8.53
17.03				115	50	899	894	"	8.32	8.27
17.11				92	60	855	861		7.88	7.94
17.18				64	80	820	825		7.53	7.58
17.21				45	100	777	782		7.10	7.15
17.27				22	150	736	739		6.69	6.72
17.32				11	200	705	704		6.38	6.34
17.36				4	250	685	685		6.18	6.18

Watch spring elasticity tests on
5th September 1888

Distension hole 15 cms.

3 Trials of following springs
(1) Elgin
(2) Waltham
(3) Dufour Lutz 1st quality
(4) Common swiss
(5) Paillard

The best were the Dufour Lutz Diam 0.018 cm × 0.005 of 22 spires. No visible distortion in alloy cm

2nd Waltham. Diam 0.9 cm 20 spire 0.030 cm × 0.005 cm
(1) slight distortion of outer spire
(2) do do (barely) visible
(3) No visible distortion

3rd Paillard Diam 1.05 15 spires 0.023 cm × 0.009
(1) very slight dishing
(2) 0.1 cm do
(3) 0.1 do.

4th Elgin Diam 0.8 13 spire 0.025 cm × 0.006
(1) 0.3 cm. dishing
(2) 0.2 -
(3) 1.25 -

5th Common swiss spring 0.7
(1) 3.2 cms dishing 12 spire 0.018 × 0.005
(2) 0.3 -
(3)

Removed the spring from Waltham # 3.534.804 cm #5 applied to Tracy movement alloy spring
14 spire Diam 0.8 0.025 × 0.009
Distension of 10 cms 0.75 dishing
- 15 - 4.0 -

Trial #2 heated steel spatula to red heat in blow pipe flame then dropped new spring upon it and watched for distortion.
3 hrs.

The best was the Waltham
(1) No visible distortion
(2) slight distortion
(3) very slight distortion.
Lutz + Paillard about equal

3
(1) slight distortion eccentrically
(2) very slight
(3) do. do.

2 Paillard
(1) very slight
(2) perfect
(3) very slight

4 Cheap swiss
(1) very bad distortion
(2) - - interbend.

Tested these springs for temper by distension.
15 cmo.

(1)	Lutz best	(1)	none visible	
		(2)	-	-
		(3)	-	-
(2)	Paillard	(1)	0·05	dubious
		(2)	0·2	-
		(3)	0·1	-
(3)	Waltham	(1)	0·3	-
		(2)	0·2	-
		(3)	0·8	-

(4) Cheap swiss not necessary to try

Thursday 6th September

Multipolar Converter ready for winding

Used two coils for winding

5 lbs of #24 BWG 0·022"

11½ . . #18 B&S 0·040"

3 turns of the fine wire carried 9 layers.

= 27 turns x $\frac{240}{6}$ = 1080 convolutions per sector

+ 1 turn of the coarse wire in 3 layers

carried by - - - - - - 3 layers

= 3 double turns per block = 120 double turns per sector.

Alternating Current Electrolysis.

3rd September.

Tried 3 voltameters again in series as before gradually shortening the wire. 10% H_2SO_4 c.p. wt.

193·5 alts per sec.

No. of cell	Time	Secs. of current	Diameter inches	Diameter cms.	Length inches	Length cms.	Gas developed c.c.	Voltmeter Rdg.	Voltmeter volts	Ammeter Rdg.	Ammeter amps.	Cell vol.	Remarks
I	10·15 - 21·30	390	0·001	2·5×10⁻²	0·42 0·24	1·05 0·602	10·9	93	113	1·		13·44	Slight condensation on evolved by globules of liquid on surface of glass.
II	10·15 - 21·30	390	"	"	0·53 0·76	1·33 1·91	9·2	"	"			13·44	
III	10·15 - 21·30	390	"	"	0·22 0·264	0·552 0·660	12·0	"	"			13·44	

Constant 1·5442 × 1·933 = 2·981 Vol. Dog. Const.

Repeated experiment with still finer wire.

No. of cell	Time	Secs. of current	Diameter in.	Diameter cms.	Length in.	Length cms.	Gas developed	Voltmeter Rdg.	Voltmeter Mean	Ammeter Amps.	Cell vol.	Remarks
I	11·25 - 21·30	390	0·001	2·5×10⁻²	0·42 0·264	1·05 0·602	9·5	96	115		13·37	
II	11·25 - 21·30	"	"	"	0·13 0·11	0·33 0·28	12·8	"	"			
III	11·25 - 21·30	"	"	"	0·22 0·264	0·55 0·66	12·5	"	"			

Repeated experiment with still finer wire.

No. of cell	Time	Secs. of current	Diameter in.	Diameter cms.	Length in.	Length cms.	Gas developed	Voltmeter Rdg.	Voltmeter Mean	Ammeter Amps.	Cell vol.	Remarks
I	16·8·30 - 11·25	195	0·001	2·5×10⁻²	0·05 0·10	0·126 0·257	3·5	96	106		3·56	16·5 alts but corr. reduced to 1·6440 of 1·6440
II	"	"	"	"	0·05 0·05	0·126 0·126	3·5					
III	"	"	"	"	0·10 0·13	0·257 0·328	3·5					

Found Condenser to have imperfect insulation (the lowest has been on a very damp day) 201,000Ω on a dry day about 1M. The capacity of it was therefore difficult to measure accurately).

The best value is as follows:—

The armature marked	4	0.104
" " "	8	0.187
" " "	16	0.430
" " "	32	0.875
" " "	64	1.045
	Sum	2.641
	Measured total	2.675

Cell No.	T. time	Spec. gr. of solvent	atm. p. Mult. factor	Strength In.	Strength Cm.	Depth In.	Depth Cm.	Gas Analysis	Orientation Rdg.	Orientation Mean	Area Sq. cm	P.D. Volts	
I	16.56	2.60	693.3	0.02	0.051	0.001	2.540³	g	98°				
	17.00			0.10	0.251								
II	3.9.88			0.05	0.126	"	"		11.5°				
				0.05	0.126								
III				0.10	0.251	"	"		11.75				
				0.10	0.251								

Same experiment = continued 4th Sept. 88.

One single pair of wires fixed in the sake of insulating material were gradually reduced in length all other conditions maintained constant. The solution was 10% H_2SO_4 in distilled water. The results are shewn.

Calibrated a glass tube of about 0.4 cm. internal diameter by means of a (burettes reading) to $\frac{1}{100}$th c.c.

Observed that with 5.5 cms in tube Burette reading = 26.5

$\frac{12.4}{6.9}$ . . . equivalent to $\frac{27.25}{0.75}$ cm.

so that 1 cm = $\frac{.75}{69}$ = 0.1087 c.c.

Revs. of dynamo 11433 =

$\frac{8}{60} \times 11433$ atts per sec = 191 per sec.

Capacity 2.675 f

Constant = $5.43 \times 2.675 \times 1.91 \times 10^{6} \times$ time $\times$ volts mean $\times 10^{-7}$

$= 2.775 \times t \times E \times 10^{3}$

Section added to mean

No.	Time	Capacity cu. ft.	Volts per revolution	Diameter wire in.	Diameter wire cm.	Length in.	Length cm.	Area sq. cm.	Length tube	Vol. displ.	Calculated volume
I	14.45.00 14.45.45 45 secs.	76°	89.5	0.001	2.5154	0.75 0.72	1.907 1.827	1.2354×10^{-3} 1.2354×10^{-3}	8.3	0.901	1.118
II	15.07.00 07.45 45 secs.	95°	89.1	"	"	0.48 0.50	1.205 1.255	0.7854×10^{-3} 0.7854×10^{-3}	9.3	1.010	1.113
III	15.23.00 23.45 45	75°	89.1	"	"	0.14 0.17	0.351 0.427	2.776×10^{-3} 3.3×10^{-3}	9.6	1.040	1.113
IV	15.33.00 33.45 45 secs.	75°	89.1	-	-	0.10 0.11	0.251 0.276	1.97×10^{-3} 2.18×10^{-3}	10.4	1.13	1.113
V		80°	92.25			0.04 0.07	0.100 0.176	7.9×10^{-4} 1.39×10^{-3}	expanding	removed.	
VI	16.13.00 16.00 60 secs.	80°	92.25	0.0014	0.018	0.66 0.63	1.66 1.58	5.2×10^{-3} 4.9×10^{-3}	11.1	1.205	1.536
VII	16.23.00 23.50 50 secs.	78°	90.8	"	"	0.38 0.38	0.952 0.952	3.0×10^{-3} 3.0×10^{-3}	9.95	1.080	1.260
VIII	16.33.00 33.50 50 secs.	77°	90	"	-	0.22 0.22	0.551 0.551	1.72×10^{-3} 1.72×10^{-3}	9.5	1.032	1.249
IX	16.43.00 44.00 60 secs	80°	92.25	-	-	0.13 0.11	0.326 0.276	1.018×10^{-3} 0.8639×10^{-3}	11.7	1.271	1.536
X	16.53.00 53.45 45 secs	79°	91.35	-	-	0.06 0.06	0.151 0.151	5.51×10^{-4} 5.51×10^{-4}	9.75	1.059	1.140
XI	17.03.00	80°	92.25	-	-	0.04 0.03	0.10 0.075		expanding	removed	

As it was evident from the smell of the gas and apparently also from the globules of water on the inside of the tube that ozone was developed and that this vitiated the results experimented on the use of sodium hyposulphite $Na_2S_2O_3$

Prepared a solution of 10% pure H_2SO_4 in distilled water and added to this the $Na_2S_2O_3$ in small quantities. Discovered however that a reaction took place viz

$$H_2SO_4 + Na_2S_2O_3 = Na_2S_2O_4 + S + SO_2 + H_2O$$

by which a gas was formed and sulphur precipitated. The results obtained with this solution were therefore rejected.

A new solution was then made up of pure water. The evaporating dish diam. 11.2 cms held this to 4.3 cms depth = 423.7 c.c. or 423.7 grammes.

Monday) 10th September

Experiment with meter continued.
The four cells last experimented with were employed.
Two (nos 1 + 2) were connected up in the meter and a current of about 2·5 ampères sent through them. Two others (nos 3 + 4) were left disconnected. Before starting the resistances were

Cells No.	Time	Ri in cub.	Mast	Pur. Ind T.Z.	Pur. Ind F.Z.	Lads	Pur. Ind T.Z.	Pur. Ind F.Z.	T.Cas
1	17.10	720		2·26	2·23	0·61	1·65	1·62	77°
2	·15	100	10	2·14	2·13		1·53	1·52	
3	·18	23·2°C		3·14	3·12		2·53	2·51	
4	·20			2·61	2·59		2·00	1·98	

The next trial was on the 6th September after some 30 hours current supply.

1	9·06	750		2·57	2·57	0·61	1·96	1·96	
2	9·09	100	10	2·45	2·45		1·84	1·84	62°F
3	9·02	17·3°C		3·50	3·50		2·89	2·89	
4	9·00			5·30	5·15		4·69	4·54	

The next trial was on the 7th September

1	9.56	340		2·37	2·37	0·60	1·77	1·76	
2	·58	100	10	2·26	2·26	~~1·60~~	1·66	1·66	67°
3	10·00	19·3°C		3·49	3·44		2·89	2·84	
4	·02			5·52	5·39		4·92	4·79	

The next trial was on the 10th Sept.

Cell No	Time	Res. in cct.	Mes	T.Z. observed	F.Z. observed	Res. bridge	T.Z.	F.Z.	Temp. cell
1	9.20	700 ω	-	2.23	2.20	0.60	1.63	1.60	71°F
2		1000/10	10	2.23	2.21		1.63	1.61	
3		"		3.40	3.37		2.80	2.77	
4		"		7.40	7.00		6.80	6.40	

The two cells that have hitherto taken current have now been cut off and disconnected while the two hitherto disconnected were now put into metre + current pass.

Next test after 24 hours on the 11th Sept.

Cell No	Time	Res. in cct.	Mes	T.Z.	F.Z.	Res. bridge	T.Z.	F.Z.	Temp. cell
1	8.00	690	.	2.80	2.74	0.60	2.20	2.14	
2		1000/10	10	2.67	2.65		2.07	2.05	72°F
3				2.37	2.37		1.77	1.77	
4		23.		2.77	2.77		2.17	2.17	

Next test after 24 hours on the 12th Sept.

Cell No	Time	Res. in cct	Mes	T.Z	F.Z.	Res. bridge	T.Z.	F.Z	Temp. cell
1	9.50	620	10	2.65	2.60	0.60	2.05	2.00	
2		630		2.82	2.77		2.22	2.17	69°F
3				2.43	2.38		1.83	1.78	
4				2.63	2.55		2.03	1.95	

Calculation for the Correction of the Temp. & oxide errors in meters.

1st By changing the size of the spool from 6 to 4
2nd " altering the res. of the spools as well
3rd " " " shunt.

If the current passing through the meter be . C
" " " " " cell " c
" " resistance of the shunt be s
" " " " " spool be r
" " " " " bottle b

Then $c = \frac{Cs}{b+r+s}$

Also if we decide that an alteration of res. under any circumstances of ~~a~~ u in the bottle shall not produce a change of current exceeding x per cent in the ~~cell~~ bottle we have

$$100 \times \frac{\frac{Cs}{b+r+s+y}}{\frac{Cs}{b+r+s}} = 100 - x$$

$$\therefore 100(b+r+s) = (100-x)(b+r+s+y)$$

$$\therefore y = \frac{x}{100-x}(b+r+s)$$

$$\text{and } x = \frac{100y}{b+r+s+y}$$

$$b = \frac{100y}{x} - (r+s+y)$$

$$r = \frac{100y}{x} - (b+s+y)$$

Here if $s = 0.01$ $r = 8$ and $b = 2$ y being 0.5
$x = 5\%$.

To make x 1% we have $r = 48.50 - (2.5) = 46.5$
" " 2% " $r = 25 - (2.5) = 22.5$

Tested the solution in the meter bottles for acidity. Took litmus test of solution in bottle 10 which had remained inactive and also of solution that had taken current for a week. No visible difference between them.

Took the weights of the idle zinc plates one of which was pure and the other 1% Hg.

10th Sept. 18. 0.

The 1%	24·0566 on 24th Aug	=	24·0752 on 10th Sept.
- 0%	23·7536 - - -	=	23·7576 - - -
Gain of 0%	0·0340		
- 1%	0·0186		

S. Dyne.

Tuesday 11th September

Compared Galvanometers.
Black fibre renewed and instrument adjusted.
Siemens Dynr. adjusted.
Gaugain Galvr. adjusted
Passed current from Main through platinoid res: and took P.D. off a certain part of it in Daniel volts, the res: being subsequently measured.

P.D. Daniel volts	Current in Amps	Siemens Tan		Gloah Deflects	Gloah Curnts	Ring		Gaugain	
1·230	1·098	83°	[7·218 / 82·19']	0·200	0·182	8°·02	[0·1288 / 7·20']	55°	[1·313 / 52·45']
		Siemens Dynr							
1·910	8·205	65°	0·8915 T_{a}	1·30	0·158	42°	[0·1798 / 8·16']		

Wednesday 12th September

Took following comparison of Galvanometers

Mr D. in Gray Light Ohm	Galv: Diff. for 0.06 water shunt	Obach crossed cut	Swinnow Ring tangent	Gaugain	Swinnow tangent	Kohlrausch Dynm.		
0.290	22	0.06						
	116.3	0.2370	13°.45					
1.477 on 1000	59.0 on 1000	0.588		8°	34°.30'	10.3 doubtful at 27 Ohm Lt.		

The current in the first instance was 0.290 amp
The next current was $\frac{290 \times 116.3}{22} = 1.533$
- Third - - 0.0014477

The Constants are therefore $\frac{59}{22} \times \frac{1}{2} \times \frac{1}{1000} = 0.0013441$

Obach Coarse	Fine	Ring tan	Gaugain Fine		Swinnow tangent Coarse	Fine	
Ten for amp 0.178	Ten for amp 0.398	Ten for amp 0.1536 8°.45		Ten for amp 0.0921 5°.26'		Ten for amp 0.2654 24°.57'	

Swinnow Dynm. gives 136°.20' for 1.915 on Obach
- Constant of $0.962\sqrt{\text{Ten}}$

Kohlrausch Dynm. gives 7°.8'.15" for 1.4477 amp.

Wednesday 12th September.

Res. of Galvanometers Temp Room 22.2 °C T.B. 21.3 C.

Obach Coarse Negligible

Fine 1000/1000 2231.5 − 0.5 = 2231 ω

Gaugain Coarse 0.031 ω (0.579 − 0.548 leads)

Fine 51.64 ω

Siemens Coarse 0.084 ω

Fine 123 ω

Kohlrausch Swinging coil + wire 105.75 ω

Fixed coil 43.91 ω

No.	Galvanometer	Coil	Res. @ 22 °C	Deflection by Tangent	Deflection by Tangent
1	Obach	coarse	0	0.180 ln	
		Fine	2231 ω		0.398
2	Ring		0	0.1405 (87)	
3	Gaugain	coarse	0.031 ω	53° (1.327)	
		fine	51.64 ω		5° 30′ 0.095
4	Siemens	coarse	0.084 ω	82° 30′ (7.661)	
			123.0 ω		25° (0.465)
5	Siemens Dynamometer			Constant	0.862 $\sqrt{\text{Tan}}$
6	Kohlrausch	swinging coil wire	105.75 ω		
		Fixed coil	43.91 ω		

Wednesday 12th September.

Storage cell test.

2 storage cells were charged some time since for experimenting on phonograph motor and had done some small amount of work. They were discharged through 1 ω the 4 HP Ergmeter.

The rate of this was − 0.87 secs per hour.

The ~~for~~ discharge commenced at

~~13~~ 9.11. 14.20. when the error by the clock was − 26

On following morning

9.12. 8.13.19 the ergmeter indicated

8.14.00 = +41 a gain of

67 secs in 17hrs 48 mins

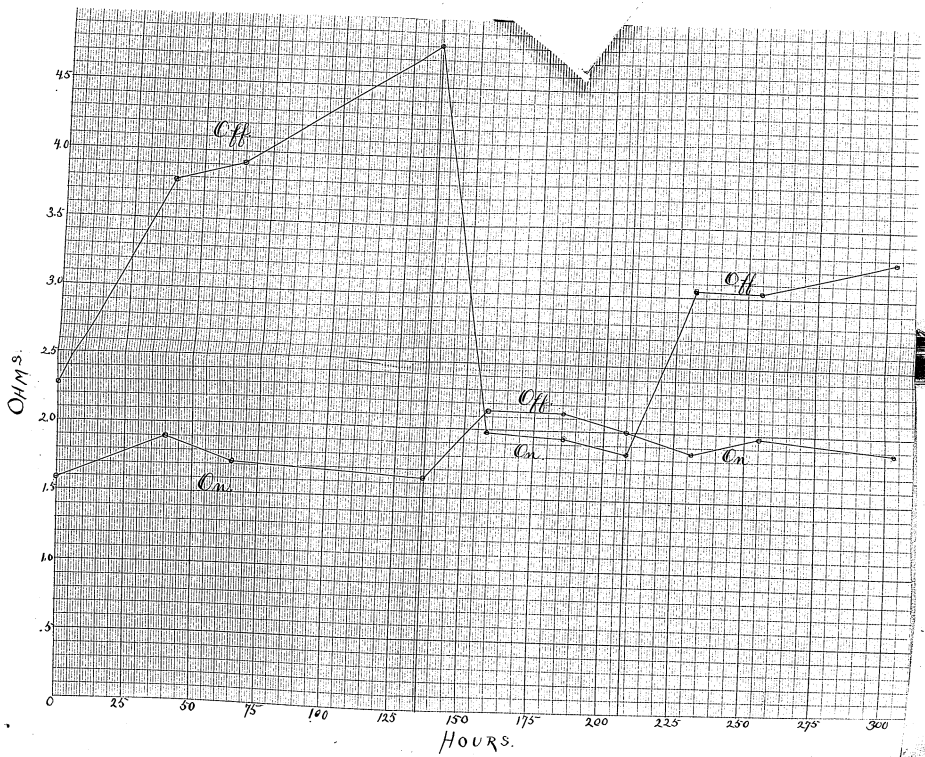
at its natural rate the ergmeter would have lost 15 secs so that the gain amounted to 82 secs

This represent by the date of the clock.

$\frac{82}{60} \times 36 \times 10^5$ Joules = 4.92×10^5 Joules

at ~~1~~ volts pressure this would be equivalent to 1.23×10^6 Coulombs this divided by 6.72×10^4

= ~~2.46~~ $\frac{123}{6.72}$ ampères = about 18 ampères.


Off
Off
Off
On
On
On
OHMS.
HOURS.
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
25
50
75
100
125
150
175
200
225
250
275
300

Meter tests continued. from page 33.

The next trial was after 24 hours on 13th Sept. as follows—

Cell No.	Time	Res. in cct	Mar	Obtained T.Z.	Obtained F.Z.	Res. Ind.	T.Z.	F.Z.	Temp
I	9.0	690	10	2.50	2.52	0.52	1.96	1.98	17°
II		1000/μ		2.57	2.62		2.03	2.08	
III				2.27	2.30	–	1.73	1.76	20°
IV		205.C		2.50	2.53		1.96	1.99	

Set up four 12 light bottles and 12 more 25 light bottles in series, with simple chromic acid, cleaned by dilute H_2SO_4 and N_2OH, no amalgamation and shellac on the top rim.

17.45

Series	Time	Res. in cct.	Mar	Obtained. T.Z.	Obtained. F.Z.	Lands	T.Z.	F.Z.	Temp
12	17.45	650	10	40.60	37.00	0.52	40.08	36.46	23°C
25		1000/μ					10.015	9.110	
				39.70	30.00	0.52	39.16	29.46	
							9.79	7.37	

After 24 hours

Series	Time	Res. in cct	Mar	Obtained T.Z.	Obtained F.Z.	Lands		
12	15.40	1000/μ	10.	50.00	43.00	0.52	49.96	42.46
25	13.9.89	700		50.00	43.70		49.46	43.16

Reversed the cells in the vessels but by putting 1 + 2 in the meter and 3 + 4 outside disconnected

Specific resistance of $ZnSO_4$ pure water solution

2 plates of pure zinc alloyed with 5% Mercury by weight were ground and polished on one face. The other sides and the rims were varnished. The Dimension were

Length 3·95" = 10·00 cms.
Breadth 2·02" = 5·18 cms.
Area 51·8 sq. cms.

These plates were separated by four little blocks of wood cut from a match, at the corners.
With separation 0·135" = 3·43 × 10⁻¹ cms. Temp. Bd. 21·7°C
Bridge 100 ~/~ 50 mms.

Test	Bridge ~/~	Mer.	Obtained Res. TZ	Obtained Res. FZ	Corrected for lead T.Z.	Corrected for lead F.Z.	Mean TZ	Mean FZ	Sp. Res.
I	100/10	2·5	0·80	0·47	0·79	0·46			
	separation	10	0·47	0·45	0·46	0·44	0·60	0·50	7.55×10^{10}
	0·3143 cm	40	0·545	0·535	0·53	0·53			
		160	0·605	0·570	0·60	0·56			
II	separation	2·5	1·02	1·00	1·01	0·99			
	0·24"	10	1·00	0·92	0·99	0·91	0·87	0·83	7.05×10^{10}
	0·61 cm	40	0·81	0·75	0·80	0·74			
		160	0·69	0·68	0·68	0·67			
III	separation	2·5	1·45	1·45	1·44	1·44			
	0·46"	10	1·49	1·47	1·48	1·46	1·38	1·34	5.86×10^{10}
	1·17 cm	40	1·45	1·45	1·44	1·44			
		160	1·15	1·05	1·14	1·03			

The areas and dimension of different metre plates are as follow.

No. of Plate	Length		Breadth		Thickness		Area of any face of side		Area of 3 sides of trim		Total area	
	In.	Cms	In.	Cms	In	Cms	Sq. in.	Sq. cms	Sq. in	Sq. cms	Sq. in.	Sq. cms
6	0.80	2.05 ~~1.75~~	0.75	1.875	0.25	0.603	0.5625 1.1250	3.6~~6~~ 7.680	0.568	3.632	1.688	11.3~~7~~10
12		4.7		1.9		0.6		8.93 17.86		6.78		24.64
25		7.7		2.5		0.6		19.25 38.50		10.74		49.24

Inside Reductions

No	Reduction for length that breadth				Area of		Depth of collar		Areas cut by collar		Total area exposed for wear in 1 plate on one side	
	In	Cms	In	Cms	Sq. in	Sq. cms	In.	Cms	Sq. in	Sq. cms	Sq. in	Sq. cms
6	0.80	2.05	0.25	0.65	0.20	1.33	–	–	–	–	0.40	2.66
12		1.0		0.65		0.65		0.7		0.34		2.07
25		1.1		1.4		1.54		1.3		1.33		5.74

Table of External Reductions.

Plate	Nut Diam		Area of do		Total nut area		Screw head Diam		Area of do		Total Screw head area	
	In.	Cm.	Sq. in	Sq. cm	Sq. in	Sq. cm	In	Cm.	Sq. in	Sq. cm	Sq. in	Sq. cm
6		0·80		0·50		0·50		0·55		0·24		0·24
12		0·80		0·50		1·00		0·55		0·24		0·48
25		1·35		1·43		2·86		0·85		0·56		1·12

Total Reductions for existing plates.

Plate	Total inside		Total nut		Total Screwhead		Sum.		Remaining effective area on the back plate		Remaining effective area on one side plate	
	Sq. in	Sq. cm	Sq. in	Sq. cm	Sq. in	Sq. cm	Sq. in	Sq. cm	Sq. in	Sq. cm	Sq. in	Sq. cm
6		2·66		0·50		0·24		3·40		14·44 ~~[illegible]~~		9·72 ~~[illegible]~~
12		2·07		1·00		0·48		3·55		45·73 ~~[illegible]~~		22·87 ~~[illegible]~~
25		5·74		2·86		1·12		9·72		88·74		44·38 ~~[illegible]~~

Total Effective Area, if tracks cured

Plate	At present Total		Consolidated reduction		Remaining effective area		Effective area if one side plate Back area		Back area Remaining effective area		Remaining effective area on each	
	Sq. in	Sq. cm	Sq. in	Sq. cm								
6		~~19·66~~ 22·74		2·66		20·08		7·68		12·40		6·20
12		26·64 ~~48·27~~		2·07		~~46·24~~		17·86		29·35		14·67
25		~~[illegible]~~ 98·68		5·74		92·74		28·50		54·24		27·12

Calculation for Mean Current

Hook		Torsion		
30' @ 118 =	3540	40' @	33.57 =	134.28
75 @ 163 =	12223	75 @	34.27	257.00
45 @ 210 =	9.450	45 @	34.74	156.33
70 @ 225	15750	70 @	34.92	244.48
220	40960	230		792.09
11	20450			
	186			

Calculation for Current strength.

(a) by $\log_e$

Time = 229 mins = 13740 secs = 1.3740×10^4

Wt of log plate before 5.460

" " " after 5.339

loss 0.121 grms

$2 \times 0.00001039 \times 1.3740 \times 10^4 = 0.121$

$\times = 1.21 \times 10^{-4}$

$\times = (1.21 / 1.11815 \times 1.3740) \times 10^{-3} = 7.874 \times 10^{-3}$ ampere

(b) by Zn

Weight of plate before 44.3344

" " after 44.2955

loss .039

$2 \times 0.00001039 \times 32.44 \times 1.3740 \times 10^4 = 0.039$

$2 \times 1.038 \times 32.44 \times 1.3740 = 3.9 \times 10^{-3}$

$2 \times 1.038 \times 2.2444 \times 1.3740 = 3.9 \times 10^{-3}$

$2 \times (3.9 / 4.622) \times 10^{-3} = 8.43 \times 10^{-3}$ amps

3.186	3.376	7.78	44.94
7.874	7.874	7.87	7.874

Thursday 13th September

44

Measurement of Constants of Instruments

Fine wire coils

Connected up the (1) Hook fine wire

(2) Bunbitt

(3) Siemens

(4) Torsion Dyne.

with an Edison 1st meter cell and a Silver Voltameter. Battery 20 Ballands.

Weight of Silver plates: 8.0 o'clock (1) 5.4604 grms

(2) 5.5304

(1+2) 10.9924

~~Zinc plates~~: arithmetical sum 10.9908

Weight of Zinc plates 8.0 o'clock (1) 44.3344

(2) 44.1599

zero on dyne before current 9.8 } 10.00.
" " after 10.2 }

with sum 88.4939

Current on 11.29.00 off 15.29.00

sum 192 88.4933

No. of obs.	Time	Hook Fine Def	Hook Corrected Average	Siemens Def.		Bunbitt Scale Rg		Torsion Dyne Torsion Rg	
1	11.30.00	3.10		73°.30'		7.3		33.24+	
2	11.30.00	3.115		73°.30'		7.5			
3	Noon	3.120	3.186	73°.30'	73°.30'	7.5	7.75	33.9+	34.24
4	13.15	3.228	"	73°.30'		7.75		34.64+	zero 10.0
5	14.00	3.22		73°.30'		7.80		34.83+	
6	15.00	3.23		73°.30'		7.80		35.04+	

Weight of Silver plates 16 o'clock (1) 5.3288 Eq 61216

(2) 5.4174 " 61170

sum 10.7462

1+2 obs 10.9860

Weight of Zinc plates 16 o'clock. (1) 44.2952 Eq 64389

(2) 44.1904 " 64306

sum 88.4856

1+2 obs 88.4850

Constant of Instruments

Hook Fine wire	Siemens Fine wire	Bunbitt	Torsion Dyne
0.00045 per unit	0.00286 23°.12' per unit	Under indicating 1.5%	0.627 1.5% x 1.874, zero

Meter Measurements Continued.

Coil No.	Time	Res. in cet.	Mo	Observed T.Z.	Observed F.Z.	Lead	T.Z.	F.Z.	T.C.
I	8.30	700 ω	10	2.85	2.75	0.95	1.90	1.80	19.4°C
II	14.9.98	1000/10		2.74	2.70		1.79	1.75	
III				3.64	3.60		2.69	2.65	
IV		T.B. 18.1°C.		4.35	4.15		3.40	3.20	

after 24 hours

I	8.25	700 ω	Mo	2.87	2.80	0.95	1.92	1.85	16.5°C
II	15.9.98	1000/10		2.78	2.70		1.83	1.75	19°C
III		10 Mo	10	3.83	3.60		2.88	2.65	
IV		T.B. 18.5°C		4.66	4.35		2.71	3.40	

after 48 hours

I	8.20	700 ω	10	2.52	2.30	0.61	1.91	1.69	20°C
II	17.9.98	1000/10		2.44	2.30		1.83	1.69	
III		10 MΩ		3.44	3.25		2.83	2.64	
IV		T.B. 19.5°C		4.25	4.00		3.64	3.39	

Experiment then concluded.

Calculation for specific resistance.

Separation 0.09" = 0.229 cms.

@ 23.5°C. = 74° F F.Z. Res 0.9 ω.

$$\frac{51 \times 0.9 \times 10^3}{0.229} = \frac{45.9 \times 10^{10}}{2.29 \times 10^{-1}} = 2.03 \times 10^{10} \text{ or } 20.3 \times 10^{9}$$

Repeated the lower reading after removing cell from ice bath and allowing it to regain normal temperature.

No. Obs.	Time of Obs.	Res. in cell 22°.	Mag	T. cell °C	Observed T.Z.	Observed F.Z.	Leads	Leads Deducted T.Z.	Leads Deducted F.Z.
29	15.05	720	10	5.5	3.75	3.45	0.66	3.09	2.79
30	.13	"	"	6.6	2.62	2.20		1.96	1.54
31	.16	"	"	7.7	2.47	2.22		1.81	1.56
32	.20	"	"	8.8	2.41	2.25		1.75	1.59
33	.21	"	"	10.0	2.37	2.17		1.71	1.51
34	.25	"	"	11.1	2.31	2.20		1.65	1.54
35	.28	"	"	13.3	2.22	2.10		1.56	1.44
36	.30	"	"	14.4	2.13	2.11		1.47	1.45
37	.31	"	"	15.5	2.09			1.43	
38	.32	"	"	16.6	2.00	1.90		1.34	1.24
39	.32	"	"	17.7	1.98			1.32	
40	.32	"	"	18.3		1.75			1.09
41	.34	"	"	20.0	1.90	1.76		1.26	1.10
42	.37	"	"	21.1	1.82	1.70		1.16	1.04
43	.40	"	"	22.2	1.75	1.65		1.09	0.99

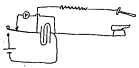
Specific Resistance tests. contd:

The same two plates exposing 51 sq. cms. of surface were again employed after cleaning. The solution was the same pure solution the sp. gr. being 1.063 @ 22°C. The all was heated in a sand bath and observations taken as it cooled. It was then put into an ice water bath & cooled further.

No. Obs.	Time of Obs.	Res. in cell 22°.	Mag	T. cell °C	Observed Res. T.Z.	Observed Res. F.Z.	Leads	Leads Deducted Res. T.Z.	Leads Deducted Res. F.Z.	Spec. Res.
1	11.14	2.900	2.5	44.4	0.99	0.94	0.65	0.34	0.29	Separation 0.229 cm.
		720	10	do	1.00	0.95		0.35	0.30	
		157	40	do	0.95	0.93		0.30	0.28	
2	.28	720	10	37.7	1.12	1.03		0.47	0.38	
3	.29	"	"	35.6	1.14	—		0.49	—	
4	.30	"	"	34.4	—	1.10			0.45	
5	.31	"	"	33.8	1.17	1.12		0.52	0.47	
6	.34	"	"	33.8	1.20	1.16		0.55	0.51	
7	.37	"	"	33.3	1.28	1.23		0.63	0.58	
8	.38	"	"	31.1	1.30	1.25		0.65	0.60	
9	.40	"	"	30.0	1.32	1.27		0.67	0.62	
10	.42	"	"	28.8	1.34	1.29		0.69	0.64	
11	.44	"	"	27.7	1.35	1.30		0.70	0.65	
12	.47	"	"	26.6	1.39	1.34		0.74	0.69	
13	.51	"	"	25.5	1.45	1.40		0.80	0.75	
14	.55	"	"	24.4	1.55	1.49		0.90	0.84	
15	.59	"	"	23.3	1.61	1.55		0.96	0.90	2.03×10^{10}
16	13.50	"	"	20.5	1.60	1.55		0.95	0.90	
17	.56	"	"	17.7	1.79	1.73		1.13	1.08	
18	14.03	"	"	15.5	2.06	1.93		1.41	1.28	
19	.05	"	"	14.4	2.10	2.00		1.45	1.35	
20	.10	"	"	12.2	2.16	2.05		1.51	1.40	
21	.13	"	"	11.6	2.35	2.25		1.70	1.60	
22	.18	"	"	11.1	2.52	2.40		1.87	1.75	
23	.23	"	"	10.0	2.73	2.50		2.08	1.87	
24	.26	"	"	8.9	2.85	2.63		2.20	1.98	
25	.30	"	"	7.2	3.10	2.90		2.45	2.15	
26	.35	"	"	6.6	3.26	2.95		2.61	2.30	
27	.50	"	"	5.5	3.41	3.15		2.76	2.50	
28	15.03	"	"	5.0	3.85	3.35		3.20	2.70	

Repeated same test with a solution of nearly saturated solution of $Zn\,SO_4$ Density 1.41 @ 18.4°. Same plates. Same conditions.

No.	Time	Rec in sec.	Mag.	T. gal.	Observed T.I.	Observed F.I.	Leads	Leads – Deduction T.I.	Leads – Deduction F.I.
1	16·38	720 sec.	10	14·4	1·23	1·11	0·66	0·57	0·45
2	·39	700 sec.		13·8	1·25			0·59	
3	·40			13·3	1·28	1·18		0·62	0·52
4	·42			12·2	1·33	1·20		0·67	0·54
5	·46			11·1	1·40	1·28		0·74	0·62
6	·49			10·0	1·44	1·30		0·78	0·64
7	·51			9·8	1·48			0·82	
8	·56			8·3	1·50	1·35		0·84	0·69
9	·58			8·8	1·49	1·34		0·83	0·68
10	17·01			10·0	1·42	1·30		0·76	0·64
11	·03			11·1	1·33	1·23		0·67	0·57
12	·04			12·2	1·32	1·22		0·66	0·56
13	·05			13·3	1·26	1·16		0·60	0·50
14	·07			14·4	1·23	1·11		0·57	0·45
15	·08			15·5	1·19	1·06		0·53	0·40
16	·09			16·6	1·15	1·03		0·49	0·37
17	·09½			17·7	1·12	1·01		0·46	0·35
18	·10			18·8	1·08	0·98		0·42	0·32
19	·11			20·0	1·055	0·96		0·40	0·30
20	·12			21·1	1·03	0·92		0·37	0·26
21	·12½			22·2	1·01	0·90		0·35	0·24
22	·13			23·3	0·99	0·89		0·33	0·23
23	·18			25·0	0·965			0·31	
24	·19			25·5	0·94	0·84		0·28	0·18
25	·20			26·6	0·93	0·83		0·27	0·17
26	·21			27·7	0·905	0·82		0·25	0·16
27	·22			28·8	0·89	0·81		0·23	0·15
28	·23			30·0	0·88	0·80		0·22	0·14
29	·24			31·1	0·86	0·79		0·20	0·13
30	·25			32·2	0·85	0·79		0·19	0·13
31	·26			33·3	0·84	0·79		0·18	0·13
32	·27			34·4	0·82	0·78		0·16	0·12
33	·28			35·5	0·815	0·77		0·16	0·11
34	·29			36·6	0·81	0·77		0·15	0·11
35	·30			37·7	0·80	0·77		0·14	0·11



Dick Key Insulating Between back of front contact

Calculation of time.

General formula. $t = 2.303\, R\, \log \frac{C}{E}$

$0.02572 \times 2.303 \times 0.001 = 2.572 \times 2.303 \times 10^{-5}$	0.000059 sec.
$0.122514 \times 2.303 \times 0.0005 = 6127 \times 2.303 \times 10^{-5}$	0.000141 .
$0.09061 \times 2.303 \times 0.0003 = 2715 \times 2.303 \times 10^{-5}$	0.000062 .
$0.26314 \times 2.303 \times 0.00010 = 2.631 \times 2.303 \times 10^{-5}$	0.000061 .
$0.58995 \times 2.303 \times 0.00010 = 5.9 \times 2.303 \times 10^{-5}$	0.000136 .
$0.33324 \times 2.303 \times 0.00010 = 3.332 \times 2.303 \times 10^{-5}$	0.000767 .

Anvil Experiments.

Took a small anvil weighing 22.5 kilos and laid it on the outer Galv room floor. On some sheet gutter pieces heavy. Time 15.30 1/9 a cell (Black) was arranged to charge the Stt 1st and by striking the anvil with a hammer so as to let it rebound the condenser could discharge through the contact and an adjustable resistance.

The hammer used weighed 128 grammes.

The Battery Galv. was employed.

No	Conditions of Floor	Full Dwell	Rest in cell	Stat Dwell after Floor	Mean	$\frac{C}{E}$	t
1	Flat end of hammer on anvil	246					
2			10000	229			
3			"	232			
4			-	230	230	$\frac{246}{230} = 1.061$	5.92×10^{-5}
5			500	184	184	$\frac{246}{184} = 1.326$	11.11×10^{-5} ?
6			300	198	198	$\frac{246}{198} = 1.232$	8.26×10^{-5}
7			100	116			
8			-	114			
9			-	119.5			
10			-	168			
11			-	124		$\frac{246}{133} = 1.834$	6.07×10^{-5}
12			-	152			
13			-	132			
14			-	122			
15			-	126			
16				133	133		
17	Sharp end Hammer		100	63	63	$\frac{246}{63} = 3.89$	13.6×10^{-5}
18	Edge of hammer flat on anvil		-	108			
19			-	131	112	$\frac{246}{112} = 2.189$	7.67×10^{-5}
20	Sharp end Hammer		-	103			
21		246					

$0.3156 \times 2.303 \times 10^{-4}$

$0.14426 \times 2.303 \times 2 \times 10^{-4} =$

Anvil Experiments contd 14th September

Used the same anvil and hammer as in yesterday's experiments.

No.	Condition of blow	Full Dia.	Res. in ect.	Obsd. Diech after blows	Means	$\frac{C}{c}$	t
1	Blunt end on anvil	244	100ω	100			
2				108			
3				123			
4				114			
5				125			
6				112			
7				70			
8				112		$\frac{244}{118} = 2.068$	7.27×10^{-5}
9				123			
10				130			
11				131			
12				130			
13				130			
14				115			
15				120			
16				131			
17				112			
18				137			
19				118	118		
20			200ω	158			
21			200ω	204			
22			200ω	170			
23			200ω	201			
24			200ω	130		$\frac{244}{175} = 1.394$	6.65×10^{-5}
25			200ω	173			
26			200ω	172			
28			200ω	183			
29			200ω	181	175		

$0.42224 \times 2.303 \times 10^{-5} =$
$0.3119 \times 2.303 \times 10^{-6} =$
$0.4041 \times 2.303 \times 10^{-3} =$
$0.0792 \times 2.303 \times 10^{-6} =$
$0.1999 \times 2.303 \times 10^{-2} =$

Anvil experiments continued.

Joined up the 113 volt terminals directly to the hammer and anvil through 0.6m of double cord and a leaden safety catch at the dynamo terminal (6mm long) and 0.06 mm diam. On striking the anvil with the hammer there was always a spark and a ~~bas~~ slight erosion of the mutual surfaces but out of six or seven trials the safety catch only broke once and that was in the case of an unfair blow.— Next tried a heavier hammer.

No.	Conditions	Full Disch	Res: insert	Disch after blow	Mean	$\frac{C}{E}$	t.
1	Same anvil & sheet as of hammer weighing 115g	24.6	100m	93			
2				84			
3				102			
4				83			
5				93		$\frac{24.6}{93} = 2.645$	9.73×10^{-6}
6				97			
7				95			
8				107			
9				102			
10				75			
11				90	93		
12	Sheet lead 0.5 thick on anvil		100	~~[illegible]~~ 12	12	$\frac{24.6}{12} = 205$	3.02×10^{-6}
13			1000m	84			
14	all three heavily dented			50	97	$\frac{24.6}{97} = 2.536$	9.3×10^{-6}
15				84			
16				180			
17	Sheet brass on anvil		1000m	205	205	$\frac{24.6}{205} = 1.20$	1.52×10^{-6}
18			100m	17			
19				50			
20				56			
21				25		$\frac{24.6}{31} = 7.932$	~~[illegible]~~ 3.97×10^{-6}
22				27			
23				12	31		
24			300	116			
25				98			
26				97			

$0.42504 \times 6.909 \times 10^{-4} = 2.94 \times 10^{-4}$
$0.25912 \times 6.909 \times 10^{-4} = 1.79 \times 10^{-4}$
$0.17435 \times 6.909 \times 10^{-4} =$

No.	Condition	Weight Dist	Brightness	Full to Dim	Mean	$\frac{c}{c}$	t.
27		300w	117				
28			116				
29			54		92.9	$\frac{247}{92.9} = 2.661$	2.94×10^{-4}
30			53				
31			75				
32			138				
33			62				
34	dropping sharp on annul	300w	75				
35			81				
36	sharp end		157				
37	" "		140				
38	flat "		182				
39	" "		111				
40	" "		100	126	136	$\frac{247}{136} = 1.816$	1.79×10^{-4}
41	" "		180				
42	" "		105				
43	" "		182				
44	" "		157				
45	" "		165				
46	cut min dark on one	300w	182				
47			175				
48			179				
49			188				
50			185				
51			178				
52			179				
53			69 ?				
54			125		168.3	$\frac{247}{168.3} = 1.494$	1.21×10^{-4}
55			110				
56			186				
57			162				
58			150				
59			172				
60			167				
				247			
				248.			

This diagram shews the connections. The cake has 8 fine platinum wire sealed into it, & the wires coming from these little plates are all covered in rubber tubing.

Alternating Current Electrolysis

Graduated a bell terminating off glass tube from a burette as follows—

Reading No.	1st Burette Reading	2nd Burette Reading	Difference c.c.	1st glass tube reading	2nd Glass tube reading	c.c. per cm of tube	Mean	Residual
1	18·40	26·60	8·20	zero scratch	29·9	0·2743		0·0059
2	30·30	32·70	2·40	do.	9·05	0·2672		0·0011
3	32·70	34·55	1·85	9·05	15·80	0·2740		0·0056
4	34·55	36·50	1·95	15·80	23·35	0·2582		0·0102
5	36·50	38·70	2·20	23·35	31·50	0·2698		0·0014
	30·30	38·70	8·40	zero scratch	31·50	0·2666	0·26844	

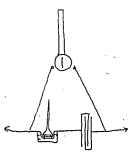
No of Reading	Residual	Sqs of Res	Sum of Sq	$\sqrt{\frac{\Sigma}{N(N-1)}}$		$0.6745\sqrt{\frac{\Sigma}{N(N-1)}}$	Probable error	Result
1	5.9×10^{-3}	34.81×10^{-6}						
2	1.1×10^{-3}	1·21	173.98×10^{-6}	$\sqrt{\frac{173.98\times10^{-6}}{20}}$	2.95×10^{-3}	1.99×10^{-3}	± 0.00199	0·26844 cc
3	5.6×10^{-3}	31·36					± 0.002	
4	10.2×10^{-3}	104·04	1734×10^{-6}	$\sqrt{\frac{1734\times10^{-6}}{5}}$				
5	1.4×10^{-3}	1·96						

A solution of 10% CP H_2SO_4 in esp. dest. was employed its density being 1·065 @ 19° C.

A glass evaporating dish 11·5 cms diam + 6·3 high (inside) = 103·9 cc cms filled to about 2 cms high = 215·6 cc. The glass tube was 37·5 cms long, about 0·6 cm int diam 0·8 ext communicating with a bell resting on a base 7 cms diam 6·3 cms high but 10 cms high to the inner base of tube. The total height 47 cms. The scratch was 2·1 cm from the top. The working cake was 5 cms in diam its upper surface 1·2 high as it rest.

Voltage Table.

No.	Gardner Reading	Corresponding Gardner Voltage	Mean alternating Voltage	No.	Gardner Rdg.	Corresponding Gardner Voltage	Mean alternating Voltage
1	80°	102.0	91.9	7	86°	106.7	96.0
2	81°	102.7	92.4	8	87°	107.5	96.8
3	82°	103.5	93.1	9	88°	108.3	97.5
4	83°	104.3	93.9	10	89°	109.1	98.2
5	84°	105.1	94.6	11	90°	109.9	98.9
6	85°	105.9	95.3				



The following table shews the length and area of the little wire plates used.

Plate No.	Diam.	Length	Cylinder Surface	Section Surface	Sum	Reciprocal	Sum from small end	Starting at 1st det.	Quantity at 1st det.
1+7	0.097"	1.5	8.39×10^{-4}	8.41×10^{-4}	8.415×10^{-4}	5.93×10^{3}	21.585		
2+8	0.0175"	1.0	5.59×10^{-4}		5.62		13.140	1 cm.	3.7 coul.
3+9	do	0.8	4.47×10^{-4}		4.50		7.520		
4+10	do	0.4	2.24		2.27		3.020		
5+11	do	0.1	0.56		0.585		0.750		
6+12	do	0.025	0.14		0.165		0.165		
Total							$\times 10^{-4}$		

The alternating Sumin Dynamo was fed by the 113 volt cct. The wires from it came to the Terminal Board thence to terminals 80, 81 thence to the south side across the room by dark cord. at the experimental table the connections were as shewn.

Marshalls Gardiner voltmeter used at first and subsequently the Elliott also.

The volts were read by the Gardner and subsequently by the Quadrant Electrometer as well.

The Machine made ~~1470~~ 1470 revs. very steadily during the experiment which was made between 17 and 18 also between 20.30 and 23.30 on the 10th Sept^br.

$= \frac{8 \times 1470}{60} = 196$ Alternations per sec.

The general formula is

$V = 5.143 \times E_{max} \times n \times k \times t \times 10^{-7}$

here $n = 196$ and $k = 4$ $\quad nk = 784 \times 10^{2}$

$V = 4.258 \times E_{max} t \times 10^{-5}$

The equivalent current $= 2n \times \frac{\pi}{2} \times E_{max} \times kt = n\pi E_{max} kt \times 10^{-7}$

$= 615.75\, E_{max} kt \times 10^{-7}$

$6.158 \times 4 = 24.632\, E_{max} \times 10^{-4}$ $\quad$ where $n = 196$. $= 6.158\, E_{max} kt \times 10^{-5}$

Calculations

No.	Equivalent Capacity on Capacity	Geometrically Calculated	Calculated Inductance	Current per cm. of plate for 1 Ampere	Power of plate per unit c.	Ratio $\frac{\text{Calc}}{\text{Obs}}$	Remarks
1.	0.0240	1.383	{20.57 / 22.54}	$\frac{1.18 \times 10^{-3}}{8.94}$	8.9444	{0.0463 / 0.053} / {0.4076 / 0.390}	Gas diminishing [illegible]
2	0.0239	5.02	{12.37 / 13.28}	7.96×10^{-3}	1.263		
3	0.0236	8.20	{9.78 / 10.46}	3.15	0.318	{0.8388 / 0.7944}	Temp 19°
4	0.0115	2.50	{2.38 / 2.55}	6.97	0.1143	{1.050 / 0.980}	
5	0.0234	7.44	{7.27 / 7.78}	14.18	0.070	{1.023 / 0.956}	
7	0.0235	7.45	{7.31 / 7.82}	average 6.26	0.160	{1.019 / 0.953}	66 Cycles = 10.89 E. q. E only 0.35
8	0.0114	3.13	{3.54 / 3.78}	average 3.04	0.329	{0.8846 / 0.826}	q. E very 0.1
9	0.0173	5.11	{5.38 / 5.72}	average 4.61	0.217	{0.9558 / 0.893}	q. E only 0.2
11	0.0293	6.57	{6.09 / 6.51}	5.01	0.200	{1.079 / 1.009}	q. E only 0.55
12	0.0294	6.57	{6.09 / 6.51}	5.01	0.200	{1.079 / 1.009}	q. E only 0.5
13	$\frac{0.01}{1.75} = 0.0102$	7.04	{12.65 / 13.53}	2.09	0.478	{0.557 / 0.526}	q. E = for the 42.8 [illegible] 0.1
14	$\frac{0.0}{3.6} = 0.0137$	8.26	{8.09 / 8.66}	5.93	0.169	{0.921 / 0.888}	q. E = for [illegible] 25 q. E = for 0.6
15	$\frac{0.0}{3.6} = 0.0137$	8.22	{8.09 / 8.66}	5.93	0.169	{1.016 / 9.95}	〃 〃

Observations

No.	Times	Capacity	Wire in set	Areas	Condenser Pots	Mean Voltage	Seconds clapping	Length of [illegible]
1	17. 13.00 / 21.00	4	1 4 12	21.56×10^{-3}	87°.45'	97.3	500	5.15
2	17. 31.00 / 36.00	4	$\frac{4}{2} \times \frac{8}{12}$	3.02×10^{-3}	87°	96.8	300	18.7
3	17. 40.00 / 46.00	4	$\frac{8}{2} \times \frac{12}{12}$	7.5×10^{-3}	88°.30'	95.7	240	30.55
4	17. 53.00 / 55.00	2	6 4 12	1.65×10^{-3}	82°	93.1	120	9.3
5	17. 57.00 / 18.00.00	4	6 + 12	1.65×10^{-3}	84°.20'	94.8	180	27.7
6	21. 20.00	4	6 + 12	1.65×10^{-3}	83°	93.9	No 6 burnt.	
7	21. 29.00 / 35.00	4	5 + 12	$\{5.55 \times 10^{-3} / 1.65 \times 10^{-3}\}$	85°.15'	95.4	180	27.75
8	21. 39.00 / 42.00	2	5 + 12	$\{5.55 \times 10^{-3} / 1.65 \times 10^{-3}\}$	81°	92.4	180	11.65
9	21. 46.00 / 49.00	3	5 + 12	$\{5.55 \times 10^{-3} / 1.65 \times 10^{-3}\}$	82°	93.1	180	19.05
10	21. 57.00	5	5 + 12	$\{5.55 \times 10^{-3} / 1.65 \times 10^{-3}\}$	80°	91.9	No 12 burned [illegible]	
11	22. 04.00 / 09.00	5	5 + 11	5.55×10^{-3}	85°	95.3	120	24.5
12	22. 06.00 / 08.00	5	5 + 11	5.55×10^{-3}	85°.15'	95.4	120	24.5
13	22. 17.00 / 27.00	7 [illegible]	5 + 11	5.55×10^{-3}	80°.20'	92.1	600	26.25
14	22. 44.30 / 49.45	2 [illegible]	5 + 11	5.55×10^{-3}	78°.00	90.4	135	30.80
15	22. 52.45 / 57.00	1 [illegible]	5 + 11	5.55×10^{-3}	78°.00	90.4	135	30.65

Measurements with resistance only in the circuit.

#13) On 708 ω increased by temp to say 720 ω the q. Electrometer reading was 42.8.

that on the voltameter was 0.1

$\sqrt{42.8} = 6.54 : \sqrt{0.1} = 0.316 :: 720 : x$

$x = 34.8$ the voltameter res.

#14) On one lamp a 96 volt 10 cp lamp the q. E reading was 35.25

while on the voltameter 0.6

$\sqrt{35.25} = 5.94 : \sqrt{0.6} = 0.775 :: x : 32.5$ $x = 224$

$: 30$ $x = 230$

#15) On the lamp 34.5 $\sqrt{34.5} = 5.87$
" " bolts 0.55 0.742 } 6.61
" both 45.05 $\sqrt{45.05} = 6.71$

$5.87 : 0.80 :: x : 30$ $x = 220$

#16 On the lamp 34.6 $\sqrt{\ } = 5.88$ } 6.55
bolts 0.45 $= 0.67$
" both 44.7 $\sqrt{\ } = 6.69$
Barlow. 77½°

#17 Prepaid potential of night cct. with Barlow and q. E lect.
106.5 volts by Potentiometer
106.5 " Dow voltmeter
85°.125' on Barlow 2
56.70 on q. E $\sqrt{\ } = 7.53$

Calculations for the starting resistance to be inserted between a #8 Dynamo and a #6 used as a motor.

The E.M.F. of the no 8 is about 125 volts. The res of a #6 armature is 0.033 ω the initial starting current ought not to exceed 20 amperes so that 6 ohm might be made the full amount, the coils might be made

⅛	¼ω	½ω	1ω	3ω	6ω
70'	60'	50'	40'	30'	20'

The carrying capacity of the separate resistances will be.

⅛	¼	½	2	3

If these be made all of the same length but the diameter be varied the res: of 1280 feet of wire $= \frac{364\,000}{d^2}$ @ 60°

1 foot $= \frac{364\,000}{5\,000} = \frac{72}{d^2}$

$\therefore \frac{72}{d^2} = 3$ or $d^2 = 24$, $d = .005$ per foot.

Say that 10 feet will be the length of wire

then $\frac{720}{d^2} = 3$ or $d = \sqrt{240} = 15.5 = 0.016'$ #27

$\frac{720}{d^2} = 2$ or $d = \sqrt{360}$ $19.1 = 0.019'$ #25

$\frac{720}{d^2} = 0.5$ or $d = \sqrt{1440}$ $37.9 = 0.038$ # 20

$\frac{720}{d^2} = 0.25$ or $d = \sqrt{2880}$ $53.6 = 0.054$ # 17

$\frac{720}{d^2} = 0.125$ or $d = \sqrt{5760}$ $75.9 = 0.076$ # 15

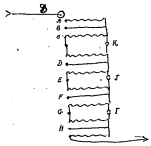
If they are all on

Mater experiments continued.

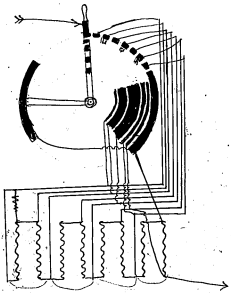
Continued from page 40

Corns	Date	Time	Resistance	Mass Tot	Bipower T.Z.	Bipower F.Z	Lude	Dolomite T.Z.	Dolomite F.Z.
12	14/9	17.40	700	10 247	70000	50000	0.53	69.5	49.5
12	15/9	8.55		22.8	69.00	49.00	0.18	66.8	48.8
			amalgamated plate						
12		11.30			35.00	32.00	0.18	34.82	31.72
12	17/9	11.35	690	22c	42.00	35.5	.18	41.82	35.32
				25 lifter corns					
25	14/9	17.00	700	10.2172	74000	50000	0.53	73.5	49.5
25	15/9	8.55			60.00	48.00	.18	59.8	44.8
			amalgamated plate						
25		13.05			16.20	15.70	.18	16.02	15.52
25	17/9	11.35	690	22c	29.10	27.30	.18	28.92	27.12

Design for a resistance coil



The rolling contact S slides from A to H. After it stops at H connections are closed at I J and K and a strip covers in succession all the contacts from H to A



Meter tests Continued:
Following are results of a set with different zeros
6 Light Meter in series. Current about 2 amperes

No. of Test	Empty	Rod	Weight 9th Sept.	Joint the Weight	Weight 17th Sept.	Joint the Weight	Loss.	Gain
1	1/4 lg	A	24.4237	47.8195	23.3875	47.850	1.0362	0.0450
2	..	C	23.3395		24.4609		0.919	1.1244
Sum			47.8232		47.8514			
3	..	E	24.6593	49.4281	24.7287	49.410		0.059
4	..	B	24.7706		24.680		0.0906	
Sum			49.4299		49.4087			
5	-	A	25.0633	49.3537	24.2325	49.305	0.8308	0.0512
6	-	E	24.2921		25.0755		0.2166	1.7754
Sum			49.3554		49.3080			
7	Plus		24.4645	50.1592	24.4169	50.1346	0.1576	1.2246
8	"		25.6947		25.7190		1.1791	0.0133
Sum			50.1612		50.1359			
11	-		24.3700		24.3226	49.1600	0.0474	0.4630
12	-		24.8637	49.3322	24.8385		0.5413	0.0215
Sum			49.2337		49.1609			
9	"		24.2814		24.2448	49.1624		0.5821
10	-		24.8982	49.1788	24.9176			
Sum			49.1796		49.1622			
13	"		25.5100	50.3734	25.4302	50.3588	0.0798	0.0550
14	5/4 lg		24.8634		24.9286			
Sum	-		50.3734		50.3588			
15	-		24.7076	49.1269	24.6226	50.1273	0.0850	
16	-		24.4201		24.5045			0.6454
Sum			49.1277		49.1271			
17	-		23.1736	47.9455	25.7403	50.4014		2.5667
18	-		24.7737		25.6604			0.6257
Sum			47.9473		50.4007			
19	1/4		23.1736	47.9455	24.7796	47.9377		0.0043
20			24.7737		23.1606		0.1130	
Sum			47.9473		47.9392		0.0001	
21	5/4		26.2166	52.4647	24.2448	52.4581		0.6266
22			26.2525		26.2115		0.0133	
Sum			52.4691		52.4563		0.0127	
23	plus	-	23.1773	47.0971	23.9274	47.1148		
24			23.9225		23.1874		0.0133	

Set up two 12 light meter side by side but kept an Edison lamp burning in the socket of one of them. Supplied them with about 4 ampères commencing at 10 o'clock 17. 9. 88. One temp. was 24·5° C and the other 42·2° C. (also about 23° C)

Gasoline experiment

Took an evaporating dish and supported on a bake plate about 3 cms high a small inverted glass vessel containing an ant. On pouring in 2 c.c. of cons. ether. The ant apparently died in about 6 mins. It revived however some time afterwards. Took the glass jar of the large storage battery and after blocking up a partition filled up the smaller compartment with Moulding sand. The dimensions of this compartment were 7 broad 21.5 long & 30 deep. At the depths of 7, 16, 19, 24, 26 and 30 cms from the surface little prisms made of thimbles were made with their open end against the glass. About 9 c.c. of gasoline were poured on to the surface of the sand this corresponding to a layer on the surface 0·06 cms high. The 7 cm ant died apparently at the end of 15 mins. The 16 cm. ant died after 19 mins. The 19 cm. ant after 40 mins and in 3 hours all were apparently dead except the lowest or 30 cm. ant which appeared stupified however. Next morning the first 7 cm. ant revived. The presence of the gasoline in these cells seemed to be confirmed by the condensation noticeable in them on the glass.

Poured some gasoline over oysters and clams both alive and closed, and also forcibly opened. No effect was noticed. An oyster solution was set apart at 10 o'clock 17. 9. 88 over the boiler to generate bacteria.

3rd Prepared a cylinder 4 cms diam × 38 high and filled it with moist but not wet sand. Poured 10 cc. of gasoline on the top. This corresponded to a layer (nearly) 1 cm in height. It visibly permeated downwards as far as 7 cms in dry and 5·5 cms in moist sand after one hour. Thereafter 6 & 7 respectively. Repeated the same with three.

4th Poured a small quantity (only four drops) on some earth worms.) Result fatal in about 5 min.

5th Took the jar mentioned above and filled it up to the height of 10 cms with sand. (ordinary red quite moist sand) The dimensions of the jar are internally 21·5 × 28·4 cm. (height 32 cms). Placed some worms at various depths in this sand, and some on the surface. Poured 150 c.c. of gasoline evenly over the top thus representing a layer 0·4 cms high over the whole area. The worms on the surface were dead in about 5 mins. Those at the bottom and ~~intermediate~~ depths were dead at the end of 90 min when the sand was examined. Most of the ~~intermediate~~ worms were found nearer the bottom than they had been placed.

6th. A clam that had been put into gasoline closed and alive, was found open and dead after some 20 hours immersion.

7th. Another clam was forcibly opened and the body suspended in gasoline. After about 6 hours, the bottom of the vessel contained about 2 c.c. of water drained from the clam.

8th. Took an old woolen coat. Tied up one sleeve to hold thermometer and then thoroughly drenched sleeve with gasoline. Temperature of air when thermometer first inserted in sleeve indicated at 82°F but the temp. of the air generally 76°F. After about 30 mins the temp. of the sleeve fell to 52°F.

9th. Repeated experiment but turned on small blast from foot bellows. No greater difference of temperature attained.

10th. Tried the other sleeve of the same coat with Rhigolene in place of gasoline. Temp. fell after about 15 mins to 23°F. (prior put on the sleeve)

11th. Repeated experiment but wringing sleeve out so that very little free rhigolene remained in it. ~~still~~ Temperature fell to 40°. only. Blast produced no visible effect.

12th. Poured a little rhigolene over a small wild pulpy leaved plant which it killed.

13th. Poured about 0.5 c.c. gasoline upon a small cricket which died nearly instantly.

14th Poured some gasoline (.0000 c.c.) 1 gall. on about one square metre of weeds in the courtyard equivalent to about 0.4 cm layer. ~~14th~~ on the 15th. All these weeds died.

15th Poured some Rhigolene on ~~two~~ small daisy weed. Plant drying in an hour. Next day plant not dead but very sickly.

16th Passed an alternating current at about 85 volts pressure through the large glass jar. The shock through the fingers felt on resting them at different points on the surface of the moist earth was distinctly appreciable. No effect however could be observed on ants or worms moving freely in the sand. The electrodes were zinc plate covering opposite sides of the jar.

17th Specific Gravity of Gasoline 0.69 @ 23°C.

18th " " Rhigolene 0.636 @ 23°C.

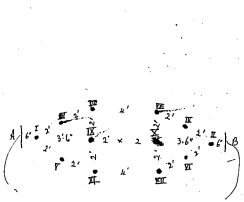
19th Poured about 1.5 pints of gasoline over roots of a bush. No destructive effect noticed.

20th Put 3 ants into a little copper vessel and corked up tightly. Then inserted same into mixture of ice and salt. The temp. fell to −5°C. The ant were exposed to this temp. for about 10 mins and were found to be dead on removal.

Magnifying power of microscope 290 diameters.

21st Put 3 ant into a small glass tube about 5 cms in diam. and 8 cms high closed with a rubber cork through a hole in which passed a thermometer. Some clean dry sand was put at the bottom to keep dry them. The whole was then inserted in melting ice.

These ants were apparently dead in 3 mins; temp. fair inside 20°C temp. " outside 24°C


A
B
2'
3'6"
2' × 2
3'6"
2'
2'
2'

To find the depth of winding a wire on the bobbins of the Octofocal.

The formula p. 11. Book 3. is

$$l = \frac{\sqrt{D^2 + \frac{4Cd}{\pi t}} - D}{2d}$$

where l is the number of layers

D - - diam: of the empty core 7.2"

C - - length of the wire 15,300"

d - - covered diam of d. 0.0925

t - - number of turns in a layer 87

$$l = \frac{\sqrt{51.84 + \frac{4 \times 15,300 \times 0.0925}{87 \times 3.142}} - 7.2}{0.1854}$$

$$= \sqrt{51.84 + \frac{5631}{273.6}} - 7.2$$

$$= \sqrt{51.84 + 22.62}$$

$$= \sqrt{72.96}$$

$$= \frac{8.60 - 7.2}{0.1854} = \frac{1.40}{.1854} = 7.6$$

$= 0.74$" depth.

The outside diam is 1.20 + 7.2 = 8.4"

inside - - - 7.2"

15.7

mean - - - 7.85"

- - circumference = 24.67"

- - layer = 24.67 × 87 = 2099" = 175 ft.

7.6 layer = 1270 ft.

Gasolene experiments Contd.

In the last experiment on page 63 #21. The ants recovered after about an hour.

22nd Put on several more ant with the same chamber, the temp. being 22°C. Then dipped the base of the vessel into ice water and watched the effect. The immediate effect was a stimulus as though the ant felt the cold through the glass instantly. The subsequent effect was a gradually increasing lethargy, and they were all motionless after some 60 seconds from first immersion although the thermometer indicated no change. After 2 hours the temp. had only fallen to 13°C. The ants however had recovered and were no longer benumbed.

23rd Poured about 640 c.c. of gasolene over a marked area of about 144000 sq mm = 0.225 sq. meter to a depth of 0.025 cm and applied a match to the ground after 10 mins but there seemed to be no chance of inflammation. It was noticed however that many worms came up to the surface as though the gasolene had driven them up from below.

24th Spec. gravity of NH_4HO sol: 0.96 @ 22°C.
" " Burma Petroleum 0.802 @ 22°C.
" " $NaHO$ 20% sol. 1.071 @ 29°C.

25th Placed some ants in a battery jar 15 cms diam. + 21 deep filled with moist coarse red sand. Poured 25 c.c. of NH_4HO spec. g. as above on the surface (equivalent layer 0.14 cm) Gas seemed to penetrate the whole jar very quickly judging from the condensation on the interior surface. After 30 mins ant apparently unhurt

26th. Repeated experiment under precisely same condition, using however crude petroleum in place of ammonia.
After 30 mins no visible effect on ant in sand. The petroleum did not seem to penetrate to the bottom so readily.

27th/8 Poured about 6/10 c.c. of gasolene over some 10,000 sq. ins. of weedy soil in yard. After the lapse of 3 mins searched with a lighted match. Found the whole surface in very inflammable condition, catching fire instantly over the whole area. It was also noticeable that after the gasolene proper had apparently all been consumed, and the ground seemed only just moist at time of ignition, the weeds themselves burned fairly readily as though the gasolene had permeated their structures.

28th. Repeated experiment over another area of 10,000 sq. ins. and waited 8 mins before applying match. Succeeded in getting a small local inflammation at one spot, but none of the weeds there caught fire, and the ignition was only momentary.

Commutating Transformer

The completed transformer is constructed as follows

One outer gramme ring Diam (outer) composed of a core of wire diam 0.046 cm. The cross cross section being a circle 2.5 cm diam. On the core are wound 32 blocks of insulated wire 0.102 cm in diam or 0.138 cm covered. Each block has roughly 0.5 ω res: so that the tot res: is about 16 ω of the gramme ring.

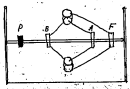
One inner gramme ring, composed of an iron wire core like the outer, but wound with two coils, in alternating blocks 32 in all. The diam: of the fine wire = " " " " coarse " "

The res: of each block of fine wire is about 13 ω and the actual resistance of the whole fine wire gramme ring is about 50 ω

The res: of each block of coarse wire is about 1 ω so that the actual resistance of the whole coarse wire gramme ring is about 4 ω.

These two circuits are brought to separate commutators, and the field or outer ring by

P. Pulley
F Field commutator
B Coarse wire or Secondary brush
A Fine wire or Primary.



The following results were obtained —
The best effect only are stated.

21. 9. 88

Time	Speed of Rotation Revs: per min	Set of Field Breaker ∠ with A	Set of Secondary Inductor ∠ with A	Dynamo effect in B amperes	Field current in F amperes	Primary current in A amperes	Increase of B's current on closing current of A amperes	Watts in circuit A	Watts in circuit B	Efficiency
11.0	950	$\frac{\pi}{2}$	0	0·7	5	0·8	2·2	32	19·3	60
15.0	1250	$\frac{\pi}{2}$	0	0·6	4	1·0	2·8	56	35	62
	"	1 section ∠ 20° at original mark	0	0·2	4	1·0	3·0	52	40	77
	"	"	0	0·2	4·1	1·0	3·1	52	43	83

29th Experiment. Set a wild plant (catnip) in a jar with its roots in gasolene, after having dried it first in the sun. The plant had shriveled somewhat before insertion but slowly recovered except the leaves and that part of the stalk that were in the jar. (Decay) finally set in after about 30 hours.

30th Tried the capillary power of Gasolene, Rhigolene and Water.

Took a tube 0.08 cm ($\frac{1}{30}$") diam, and put a portion of it vertically through the corks of each of 3 small phials containing respectively No 1 H_2O No 2 Rhig. No 3 Gasolene. The liquid rose in No 1 1.5 cms in No 2 0.4 cms. In No 3, 0.5 cm. Checked this by taking two plane glass plates and uniting two vertical edges. The plates were 10 cm. X 12 cm. and about 0.25" thick the angle being nearly 6°. The water rose the greatest. Next the gasolene, last the rhigolene. It seemed that the water took the longest time to assume the curve, gasolene the next and rhigolene the shortest time.

31st Took a small portion of cheese containing mite and poured a drop of gasolene (fr having microscopically) examined them. The effect of the drop was apparently to first stupify them but after about an hour, they recovered. The gasolene itself had by that time of course disappeared.

32nd Repeated this experiment with some other mite only using alpha naphthol. This seemed to have no effect.

33rd Tried similarly bichloride of mercury (strong solution in water). The effect of this on the mite was not apparent for about a minute and then they died.

34th Tried shigolene similarly. The effect of this was much more rapid, apparently dying instantly but after several minutes they seemed to revive and subsequently appeared unhurt. The drop of shigolene however soon disappeared by evaporation.

35th Tried the effect of gasolene in displacing water above it in a capillary tube. A glass tube 0.08cm (1/30") was partially filled with a column of coloured water and its lower end was then dipped in gasolene. No displacement was visible but slow diffusion took place.

36th Tried the effect of gasolene on the bacteria of some stagnant water. Added about equal small volumes of each. Microscopic examination seemed to show that the bacteria were killed.

37th Poured a solution made up of 50 c.c. strong comm. caustic soda and 350 c.c. Water on a small plot of weeds and grass about 60cm x 32

38th A very weak solution of caustic soda was added in drops to a drop of water having bacteria in active state. The bacteria seemed to be killed by the addition

600 grammes of pure $ZnSO_4$ obtained by Mr Watt from were added to 400 grammes of distilled water. A certain residue ~~was~~ of undissolved salt remained after much stirring and 12 hours solution at temp. of 20° C. The solution however now assumed to be (practically) saturated was filtered. It had increased between 50 and 100% in bulk but was quite transparent.

By floating hydrometer its spec. grav. was 1.14440 21.5°C
" weighing " " " " 1.14370 22° C.

Two pairs of 100 light meter plates were planed by machine and were varnished on the back and round the edge. The dimensions of each pair of plates appear in the following table.

Pair Marks	Mean length	Mean breadth	Mean area	Mean thickness	Mean inference left on one side	Mean inference left on other side	Mean inference distance	Lock Area above	Lock Area below	Wet lock Area
	cms	cms	sq. cms.	cms	cms	cms	cms	sq. cms	sq. cms	sq. cms
O	15.15	5.03	76.2 (3.9 / 72.3)	0.5	0.9168	0.9424	0.930	1.06	1.33	2.37
X	15.10	5.00	75.5 (2.3 / 73.2)	0.5	1.224	1.247	1.236	1.13	1.13	2.26

The plates were kept rigidly connected by means of two corks ~~with~~ screws through them the head and washer abutting on the backs of the plates. Strips of tape were laid against the sides of the plates to prevent circular conduction and the whole bound together with elastic bands. The top and bottom edges were not bound so as to allow free liquid passage. Since the bottom rest on the floor of the tank circular conduction can only take place at the top edge

The testing was conducted as follows:—
A clear beaker of following dimensions contained the solution.

Depth 17.6 cms.
Int. lower diam 7.0 -
" top - 7.2 -
Lip diam: 8.7.

The pair of plates were then immersed in the and measurements taken to three and four zero on the 3rd table bridge. Results follow.

Pair number	Time	Bridge etc.	Res. in cct.	Mass	Wetting F.Z.	Wetting T.Z.	Receding F.Z.	Receding T.Z.	Pole
O	10.0/22/9/11		8100	1	16.00	16.50	15.93	16.43	0.07
			1600	5	9.20	10.25	9.13	10.38	
		100 m/o T.B. 19.5°	750	10	5.80	6.67	5.73	6.60	
		Tension 21.00	122	50	2.35	2.86	2.28	2.79	
			5	250	0.60	0.72	0.53	0.65	
X	13.0/22.9.11		8000	1	7.50	8.40	7.43	8.33	0.07
		100 m/o T.B. 20°C		5	6.60	7.65	6.53	7.58	
				10	5.50	6.50	5.43	6.43	
				50	1.40	1.68	1.33	1.61	
				250	0.67	0.75	0.60	0.68	

These results seem to show a very imperfect contact between the plates, and the liquid especially in the first or O pair. The surfaces of the plates had been freshly cleaned with emery paper. They were not polished, but slightly and uniformly grooved throughout from the planer.

Calculations for the Dimensions of a Commutating Continuous Transformer of 100 light Capacity.

The coarse wire coil or secondary has to supply 50 amperes at 100 volts pressure at Machine terminals = 5100 Watts externally. The coils are to be simple Gramme rings. Suppose we give to the double Gramme ring an internal diam: of 30cms (12"), a rectangular cross section of core 6·3 cms (2½") by 2·5 cms (1") producing a mean diam: of 33 cms (13") and an external diam: (cms) of 35·6 cms (14").

The voltage at primary terminals to be 1000 and equal weight of copper to be in each coil:

To supply 6000 Watts odd the current in the primary coil must be 6 amperes. allowing 500 cir. mils to the ampere this means 3000 cir. mils = no. 17 wire B.W.G. or 0·058" diam: The length of one turn of this will be 7 cms. Assuming an average induction over the whole half ring of 1000 lines per sq. cm. and a velocity of rotation of 1200 turns per min. = 20 per sec: we have the relation

$$113 \times \pi \times 7 \times 1000 \times 20 = 1000 \times 10^8$$

$$\text{or in} = \frac{10^8}{1{\cdot}13 \times 7 \times 2{\cdot}00 \times 10^3} = \frac{10^4}{1{\cdot}3 \times 4{\cdot}4}$$

$$= \frac{10^4}{1{\cdot}72} = 5810$$

so that at the speed and induction named 5810 turns would suffice. Probably by means of the soft iron revolving frame the induction and active length of wire will increase so we will take the length of wire at 4000 turns.

The internal diam: being 30.4 cms (12") produces an internal circumference of 95.5 cm (37.7") and half of this or 47.8 cms (18.9") would be occupied by the fine wire coil. allowing reduction of 10% for insulating septa and the remaining length is 43 cms (or 17"). The area required for ~~#8~~ 40000 #17 B&S wire is $(0.058 + 0.010 = 0.068" \text{ Diam} = 3.63 \times 10^{-3} \text{ sq in.})$ $4 \times 10^3 \times 3.63 \times 10^{-3} = 14.52$ sq. in., thus requiring a thickness of nearly 1" in winding — (practically) prohibitive.

Suppose the linear dimensions of the machine to be therefore increased, say to 15" (38 cms) internal diam and 17" (43 cms) external diam. with a core whose cross section would be 2.5 cms × 6 cms 1" × 2½". The circumference would now be externally 135 cm (53.4") and with the same speed of revs (20 per sec) and induction 1500

$$n = \frac{10^8}{1.4142 \times 1.35 \times 7 \times 20} = \frac{10^8}{1.4142 \times 1.35 \times 1.4} = \frac{10^8}{1001.89} = \frac{5290 \times 3.3}{10}$$

Assuming 2000 turns of wire on each side of the primary, the internal circumference is 47.12" (119 cms) and half of this = 23.56" (59.5 cms) allowing, 10% for insulating strips, we have left 21.2" or 53.5 cms. This means 0.7" for depth of winding.

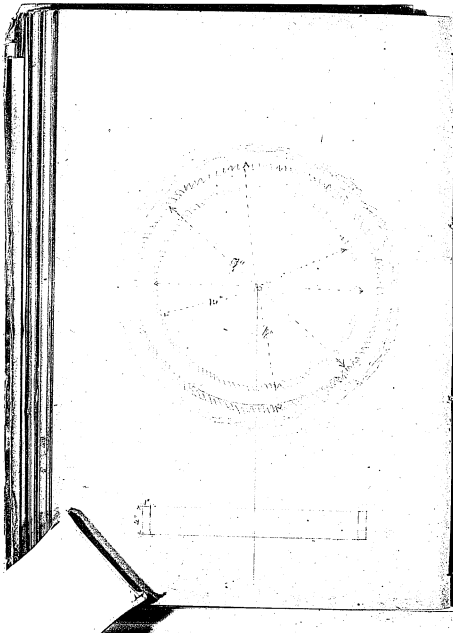
Next suppose 100 blocks in the commutator as in M, that will give 40 convolutions or an average of 20 volts per block.

2 × 2000 turns, each of say 5 ft. length give a total of ~~32000~~ 2800 feet of #17 B&S 0.058"

The weight of 1 foot is 0.01018 of 100 feet 10.18 lbs and 2800 feet = 28.5 lbs.

The wire to carry 50 amperes would at 500 c.m. = 25000 c.m. = #8 B&S 0.165" diam

To generate say 110 volts it would req



Data for a Continuous Commutating Transformer to yield 2.5 amperes at 102 volts

The inner diam = 15" (38.1 cms) = 47.1" (119.7 cms) circ.
Outer diam = 17" = (43.2 cms) = 53.4" (135.7 cms) circ.

At speed of 2000 per min. and 1500 inductors the number of turns required to produce 1000 volts

$$n \times 10 \times 1500 \times 2000 = 1000 \times 10^8$$

$$\therefore n = \frac{10^8}{3.0 \times 10^8} = 3333$$

Say that about twice the number or 7000 turns be employed since the two semicircles are in series. Since 25 × 110 or 2750 Watts have to be supplied to the secondary circuit we must arrange for 3 amperes at 1000 volts entering the primary circuit. Allowing 500 c.m. to the ampere we require $\frac{3}{2} \times 500 = 750$ c.m. in the wire = #22 wire B.W.G. 0.028" diam. Since the half internal circumference is 23.5", allowing 10% for insulating septa we have to coil 7000 wire each 0.040" diam upon a space of 21.2"

$0.04 \times 0.04 = 16 \times 10^{-4}$ sq. in. × 7000 = 11.200 sq. and this divided by 21.2 gives nearly 0.5" for depth of winding.

The length of this wire will be 7000 × (10" + 2") = 7000 feet. It weighs 2.373 lbs. per foot = 2.373 lbs per 1000 feet = 16.61 lbs. in all. The res. of 1 foot is 1.317×10^{-2} ω per foot = 13.17 ω per 1000 feet = 92.19 ω per 7000 feet = 23 ω on the whole gramme ring.

The length of the coarse wire must be at the first approximation $\frac{7000}{9}$ = 778 feet. To have the same weight 16.61 lbs it must

weigh $\frac{16.61}{778} \times 10^{-2} = 0.0214$ lbs per foot
= No 14 B.W.G or 0.083" diam.

Since the ceiling distance is 21.2" and we have to enter 778 turns upon it, each
0.095×0.095 sq. in $= 1.0 \times 1.0 \times 10^{-2} =$ ~~0.09 x 10^-2 = 0.09~~
778×0.09 ~~x 10^-2~~ $= 7.78$ ~~x 10^-2~~ $= 7.78$ sq. in.
This divided by 21.2 gives 0.37" as depth of winding. The area mult of #14 being .6889
this divided by 25 = 27.55 × 2 = 5.51 per ampere.
The res. of one foot of this wire being
1.499×10^{-3} 100' feet would have .1499 ω say 0.15 ω
and 778 feet would have 1.167 ω and the whole ring would have a res. of $\frac{1.167}{4} = 0.292$ ω
This multiplied by 25 = 7.3 volts drop of potential at full load = 111 − 7.3 = 103.7 volts at machine terminals, reduced perhaps still further by self induction.

The primary commutator to have 100 blocks like Mr. Edison, and the secondary to have 50 like Mr Edison.

The whole ring therefore to be divided into 200 ~~pole~~ segments and gramme wound.
The field ring to be subsequently discussed

The principal dimensions for the gramme ring then are

Internal. Diam of core 15" Height 4"
External " " 17"
Internal. Diam of ring wound about 14"
External " " " 15".

The Primary to consist of 7000 turns in feet of #22 B.W.G wire 0.025" diam. having a total weight of 16.6 lbs and a res. of 23 ω.

The Secondary to consist of 990 turns of feet #14 B.W.G wire 0.083" diam. having a total of 16 odd lbs and a res. of 0.25 ω

Sunday 23rd September

The last weighing of the two hot and cold meters not having been successful, Weighed the plates again after amalgamation.

17.30. No. 1 87.2018
2 88.3007 } 175.5010 observed
sum 175.5025

3 89.4658
4 89.9314 } 179.3960
sum 179.3972

5 87.9560
6 88.7720 } 176.7244
sum 176.7280

7 87.9807
8 85.8539 } 173.8351
173.8346

Sensitiveness of balance as follows.
@ 88 grammes load zero ± 12 per mgm.
@ 175 " " " ± 6 " "

Set up these better in order, with the heads of the screws against the odd numbers.

1+2 3+4 were put with in the water with the burning lamp
5+6 7+8 were put in the water with no lamp burning.

Current commenced 7 o'clock Monday 24 9.
Current 3.8 ampère Temp in Warm meter about 42°C
" Cool " 19°C

Monday 24th September.

Trial of new phonograph motor.

Res: of armature 0.216 ω
Field

A cell with new zinc and fresh solution made up in the phonograph room failed to work the machine for many minutes together. Tried a #18 solution that had been preserved.

11.30 Commenced running off

Time	Volts	Ohmes	Amp	Governing Speed	Watts	Temp.
11.30	1.51	~~[illegible]~~	2.5	188	3.78	0
12.00	1.394	0.47	2.61	188	4.16	
13.00	1.59	0.45	2.50	180	3.97	
14.00	1.574	0.45	2.50	180	3.94	
15.00	1.542	0.435	2.41	180	3.77	
16.00	1.504	0.440	2.44	180	3.69	
17.00	1.478	0.420	2.33	180	3.44	
18.00	1.423	0.440	2.44	176	3.47	
19.00	1.237	0.460	2.55	176	3.15	
20.00	1.228	0.450	2.61	176	3.21	
21.00	0.966	0.440	2.44	96	2.43	

Bell stopped running shortly afterwards.
The chromic acid solution completely exhausted

Total number of turning off completed

199

Tuesday 25th September.

Statement and Record of work for one complete day) in Engine and Boiler at Laboratory) commencing at 6.30 on the 24th inst.

Conditions

Two boilers fed during the day. Every barrow of coal was weighed and made up to 260 lbs. The ashes were also weighed.

Every lb: of water that entered the feed was recorded.

No steam was allowed to leave the boilers to supply any of the outbuildings or storeys. All the steam was fed to the engines

Diagrams were taken of both Arm-Simms Engine + the Brown Engine from time to time.

The results are shewn in the following table:—

Engine started at 7.20
Brown + No 1 - - stopped at 12.0
- - - - - - started at 12.30
No 2. A.S. started at 17.40
Brown stopped at 18.00
Brown started at 18.52
Brown stopped at 19.10
Brown started at 19.16
- stopped at 22.00
No 1. A.S. stopped at 1.00
- 2 - - - 1.50.

Boiles in same condition at close as at commencement.

26 barrows of coal were burnt each weighing 260 lbs = 6760 lbs
day 6800 -

Total ashes reduced 792 day 800
Coal burnt 6000.

Total lbs. of water 57,000 lbs.
137 barrel each of 52 gall. or 416 lbs.

The Brown engine ran 13 hours
- A.S. no 1 - 17 -
- A.S. - - - 2 - 8 1/2

The HP hrs accounted for are 66 + 3149.6 = 584
Added to this the 225 HP. by the Brown = 809
or in fact out of 919 HP 584 are accounted for

Time	Engine running						Amperes indicated	
	Brown		A.S. no 1.		A.S. no 2			
	I.H.P	Est. H.P.	I.H.P.	Est. HP.	I.H.P.	Est. HP.	No 1.	No 2.
7.0	0	0	0	0			75	
8.0		7.5		22.0			150	
9.0		18.0		44.0			150	
10.0		18.0		44.0			150	
11.0		18.0		43.8			150	
12.0		18.0	44.6	44.6			150	
13.0		8.0		22.0			75	
14.0	18.5	18.5		45.0			150	
15.0		18.5	39.7	39.7			125	
16.0	20.1	20.1		47.5			128	
17.0	14.9	17.5	43.3	43.3			130	
18.0		15.0		43.3	28.1	27.7	140	137
19.0		22.0		44.0	29.0	29.0	140	145
20.0		15.0		44.0	29.0	29.0	140	145
21.0	14.6	14.6		44.0		29.0	150	136
22.0	17.6	16.1		45.0	24.4	26.5	150	108
23.0				40.0	20.4	20.4	115	70
24.0				40.0		16.0	115	60
1.0				40.0		16.0	115	50
2.0						14.0	~~105~~	~~50~~
		224.8		730.2		189.6	1145.8	791

Total H.P. hours 1144.6
Coal burnt 6000
Coal per H.P. 5.24 lbs.
lbs. of water 57000
lbs. of water evaporated per lb. of coal 9.5

Meter work. continued.

25th September 1888.

Washed the two pairs of 100 light plates in dilute caustic soda and amalgamated them. By means of the hard rubber washers, the intervening space was made 0.635 cms for pair X and 1.270 - - " O.

Mica strips were applied as usual.

Took following series — Pair X T.B. 18°C.

No.	Time	Bridge ft	Res.	Max	T.X.	Primary F.X.	Secondary T.X.	Secondary F.X.	Spec. R.
1	9.15	1000/10	7900	1	0.63	0.50	0.54	0.41	
2		Temp at 18°C.	770	10	0.62	0.56	0.54	0.47	2.76 x10
3			115	50	0.605	0.58	0.52	0.49	
4		Xcmple	4	250	0.587	0.568	0.50	0.48	
	Wint	solution							
1	10.00	1000/10	7400	1	0.66	0.60	0.67	0.51	2.95x10
2		Temp at 15.6°C.	720	10	0.62	0.60	0.53	0.51	
3			117	50	0.605	0.595	0.52	0.51	
		Xcmple							
	Wilmotti	solution							

The sp. g. of the Wint Solution by Hydr. 1.444 @ 15.8°C
" " " " Wilmotti " " 1.433 @ 15.6°C
" Hight 1.473 @ 17.0°C

1	10.25	1000/10	7600	1	0.345	0.345	0.26	0.26	
2		Temp at 16°	740	10	0.405	0.36	0.32	0.27	
3			120	50	0.39	0.37	0.30	0.29	
4		Xcmple	5	250	0.377	0.36	0.29	0.28	
		Wint solution							

Repeated results with solutions maintaining however a constant current and altering the temperature.

No	Time	Bulb temp.	Max.	T. cell	Observed T.Z.	Observed F.Z.	Corrected for the bulb T.Z	Corrected for the bulb F.Z.	Sl. P.
1	11.27	5 Early 100 Pm T.B. 1.40 95	50	60°c.	0.875	0.865	0.108	0.095	~~4.64~~ 11.36
2	12.03	100	50	50°c.	0.912	0.900	0.125	0.133	15.40
3	13.20	95	50	38.8°c	0.995	0.980	0.228	0.213	24.66
4	14.25	100	50	7.0°c.	1.895	1.895	1.128	1.128	130.6
5	10.25		50	16°c.			0.30	0.29	33.6
1	11.20	95	50	60°c	0.960	0.960	0.193	0.193	11.2
2	12.00	110	50	50°c	1.013	1.00	0.246	0.233	13.5
3	13.23	95	50	38.5°c	1.140	1.130	0.373	0.363	21.6
4	14.20	100	50	7.0°c	2.200	2.160	1.433	1.393	80.7
5	9.15		50	16.8°			0.52	0.49	28.4

The temperature of the cells was raised to 60°c by immersing it in a vessel of hot water. The temp. was read between the plates. The res. at the lowest temp (7°) may have been increased by the crystallization that took place there. Solution with their bulb.

Two thermometer were successively set in a cup in ice. The zero thermometer then indicated to 3 - 5° " " " - 0.2

Tuesday 25th September.

Ran another same phonograph motor as in the last test with a fresh zinc and solution and all other conditions maintained except that the speed was kept by the governor at 125 revs. per min. The following is a statement of the results obtained, also plotted on the accompanying curve:—

No. of Det.	Time	Speed	Black Def.	Ampere	P.D. at machine terminals	Watts in machine
1	11.00	125	0.44	2.44	1.646	4.016
2	12.00	"	0.445	2.47	1.634	4.036
3	13.00	"	0.43	2.38	1.642	3.91
4	14.00	"	0.44	2.44	1.634	3.99
5	15.00	"	0.45	2.50	1.594	4.20
6	16.00	"	0.445	2.47	1.560	3.85
7	17.00	"	0.44	2.44	1.526	3.72
8	18.00	"	0.43	2.38	1.489	3.54
9	19.00	"	0.44	2.44	1.368	3.34
10	20.00	"	0.44	2.44	1.342	3.27
11	21.00	"	0.445	2.47	1.206	2.98
12	22.00	116	0.415	2.31	1.021	2.36
13	22.15	52	0.410	2.27	0.523	1.19
	Total	no. of	eggs	burning off	completed	165

Gasolene experiments contd.

Prepared following estimate of lowest possible commercial prices of prophylactics :—

Bromine	37 cts per lb.
Chloride of lime	2 . . .
Chlorine Water	10 . . .
10% Solution Caustic Soda using 48% Crude	0.25 . . .
Gasolene	1.
Rhigolene	16
Bisulphide of carbon	10
Corrosive sublimate	57

1 U.S. gallon will cover 1.2 sq. yds to a depth of 1/8".

Sept. 25th. Mounted a new specimen of chaoemites under the 40 dam power of microscope. They were alive and active. Poured a few drops (perhaps 2) gasolene over them. This stupefied them for a time but they afterwards entirely recovered.

(2) After their revival poured one or two drops of 20% (about) solution Caustic Soda all the mites died within 15 mins.

(3) Mounted another specimen of live mites and treated them with a drop of solution composed of 5 cc. H_2O 10 drops gasolene + 10 drops NaHO. This was not fatal.

(4) Mixed equal volumes of gasolene + caustic soda. Then used a drop of so of the above solution on another specimen. This rendered them motionless for about 15 mins but they recovered.

Meter experiment continued.

27th left:
Found lamp in hot meter under test broken at about 9.20. It was burning last night so that only a few hours of heat have been lost.

Prepared a new solution as follows:—
Took 450 c.c. of the concentrated sol. whose sp. gr. was measured again as follows—

1.430 @ 25°C by balance
1.440 @ 23.8°C - Hydrometer
1.440 @ 23.8°C - - from Pharm. Rom.

added to this 50 c.c. of distilled water
So that the solution is now 90% of its previous strength.
The sp. gr. of the new solution was

1.401 @ 24.5°C by balance
1.410 @ 23.8°C - Hydr.

Revarnished zinc plate with some of Mr. Hall's varnish.
Set aside in a labelled bottle about 100 c.c. of the primitive solution.

26th Sept.

Received a complete set of Becker Scale + weight from the Edison Co. through Mr Wirt. The 1mgm + riders only) missing.

Tested the weights as follows –

The 500 gramme weight is 0·001 less than sum
2nd 200
100
100
chemical 100 500

" 200 " " " 0·001 less than sum of
100
100 200

" two 100 " " " are practically) equal.

" 100 " " are about 0·001 more than the collective 100.
50
20
10
10
5
2
2
1 100

The sensitiveness of the balance is

8 per mgm @ 500 gramme load.
15 " " @ 200 " "
18 " " @ 100 " "

The periodic time of one complete vibn of the balance is 52·3 secs approx @ 100gm load.

Gasolene experiment contd.:

(5) Used equal volumes of 90% caustic soda + H_2O. Treated another specimen with this & found it fatal.

(6). Used solution of 90% H_2O 10% $NaHO$ on another specimen & found it fatal.

(7). Made a solution of sp. g. 1.067 same 10% solution & found it invariably fatal in mins.

(8) 23rd Sept. 14.0. Prepared 3 small grass plots each about 50 cms × 50 cms. = 2500 sq. cms & poured upon on $NaHO$. 10% Solution 1500 cc.
on the second Gasolene 1500 cc
on the third Half Gasolene & half 10% $NaHO$ 1500 cc.
On the 26th. The effect was visible
" 27th. The $NaHO$ appeared to have been most active then the gasolene, & the mixture best. All had been fairly fatal to the grass. Depth of imaginary layer 0.6 cm.

26th Septr. Poured an egg into water after stirring it to purify).

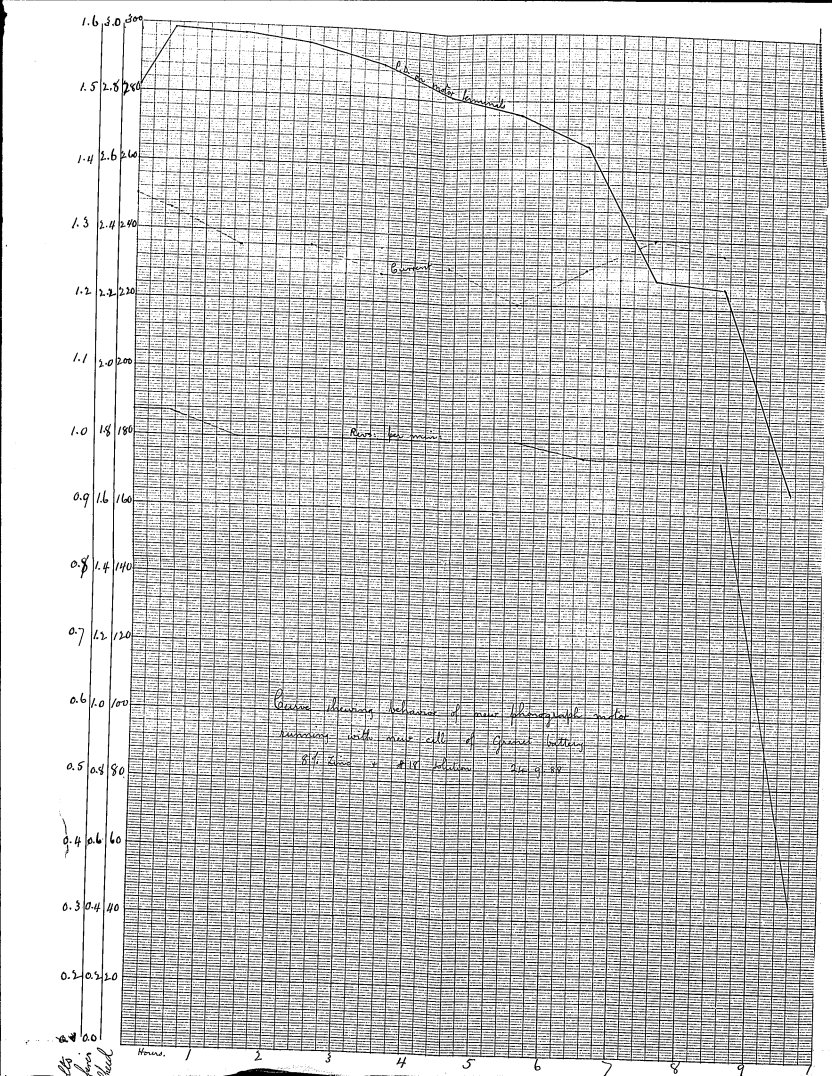
27th Septr. Tested a drop of stagnant water under 500 power of microscope & found it to contain bacteria. Then added a drop of gasolene & could find no more movement in them.

Tried 10% $NaHO$ with equal success.

Set 3 solutions to purify in corked bottles set in a battery jar round an Edison lamp feebly illuminated to sustain life.

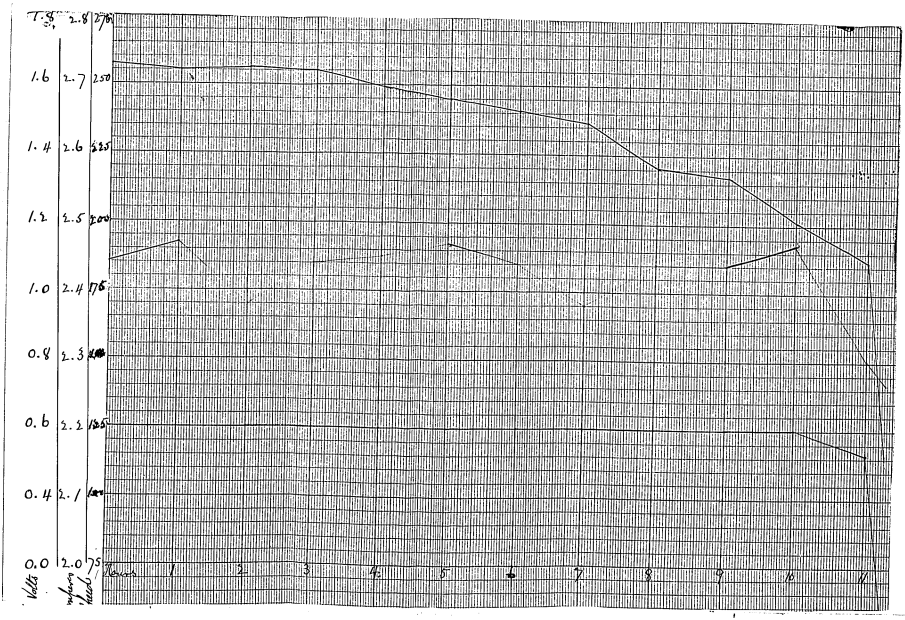
Index.

Alt. Cur. Electrolysis 12, 15, 23, 28-31, 52-55.
Anvil Experiments 48-51.
Boiler & Engine Test 80, 81.
Converter, Multipolar 27.
Determination of λ 2-4.
Earth Plates 44.
Engines Tests 1, 17.
Galvanometers, Constants & Comparison of 36-38, 44.
Gasoline Experiments 60, 66, 67, 70, 71, 85-88.
Motor Tests 5-7, 13, 14, 18-24, 32-35, 40-43, 45-49, 57, 59-66, 73, 74, 78, 82, 83, 86, 87.
Octopolar, Depth of Winding of Bobbins 65.
Pendulum, Period of Oscillation 16.
Phonograph Motor 18, 79, 84.
Physiological Experiments 11.
Resistance between 6" Dynamos & 6" Motor 56.
Resistance Coil, Design of 58.
Storage Cell 39.
Transformers 68, 69, 74-77.
Watch Test 1.
Watch Shield Test 8, 9, 10.
Watch Spring Test 25, 26.

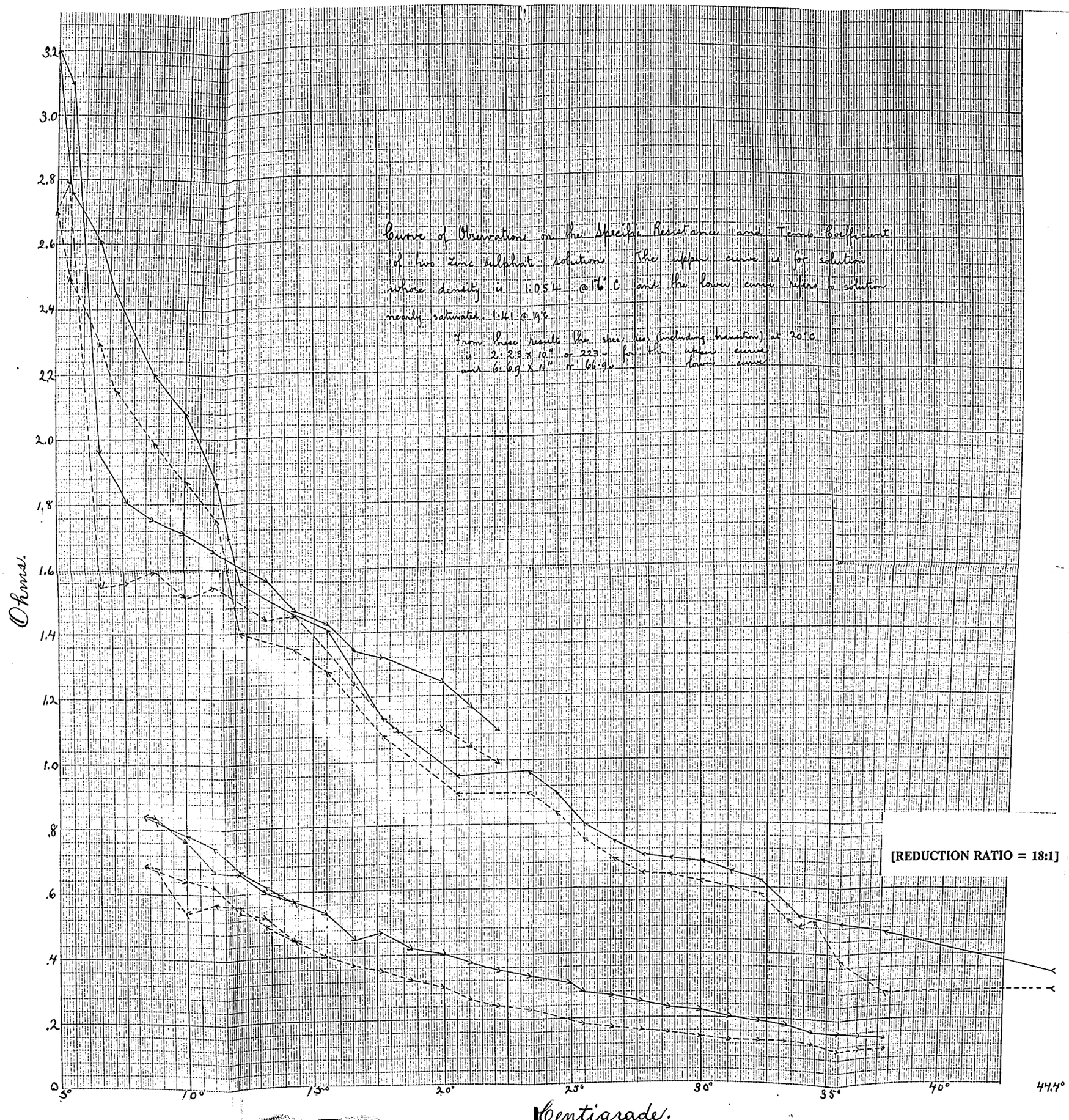


[ITEM FOUND IN BOOK]

[ITEM FOUND IN BOOK]

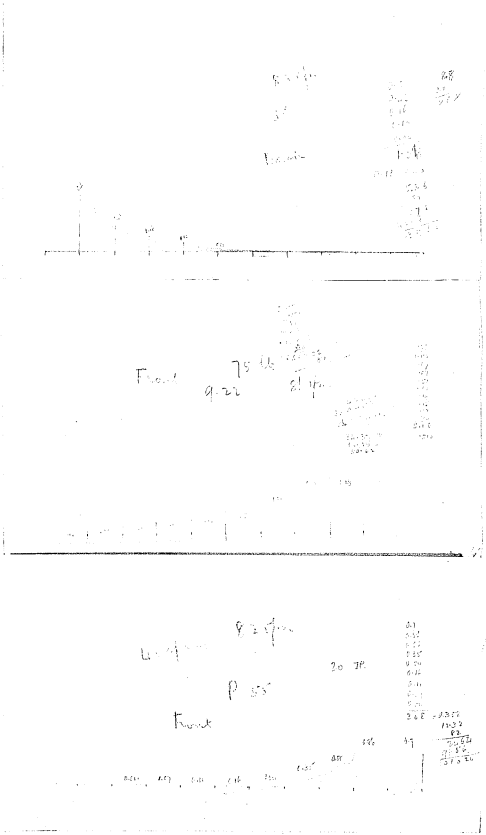


[ITEM FOUND IN BOOK]



[REDUCTION RATIO = 18:1]

[ITEM FOUND IN BOOK]



Notebook, N-88-09-28

This notebook, which covers the period September-October 1888, is a continuation of N-88-08-28. It contains transcriptions by Arthur E. Kennelly of material from the rough record books used by experimenters in the Galvanometer Room. Included are notes, drawings, tables, and calculations regarding meter and multipolar dynamo experiments, phonograph battery tests, and tests of an electric motor to run a blower at the phonograph factory. Some of the entries relate to the transmission of power from Niagara Falls to Buffalo and to physiological experiments using gasoline on bacteria. Among the experimenters whose work appears in this book are F. P. Bergh, E. C. Boynton, Alex W. Brigham, Johannes H. Cuntz, T. F. Lawrence, and Charles Wirt. The front cover is labeled "#525" and "Record Book No VI Galvanometer Room." The spine is labeled "78." The book contains 56 numbered pages.

Two oversize graphs, formerly pasted onto pages 42 and 51, have been filmed at the end of the book at a reduction ratio of 18:1.

XE-172 N-88-09-28

Record Book

No VI

of Observations Calculations and

Data in the Galvanometer

Room Edison Lab.ry

Commenced 30th September 1888.

Meter Experiments cont.

29th September. Tested the sp. g. of the new F2 solution prepared yesterday.
By Hydrometer 1·415 @ 20·1°C

Took a series of readings similar to those of yesterday, with the plates reamalgamated and washed. The varnish lent by Mr Watt consisting of a mixture of asphalt and rubber was not successful so far, in the manner adopted.

The following table gives readings both with ~~both~~ and without hale flanks:—

No	Time	Plates	Bridge	Res.	Mun.	T.Z.	F2		
						with hale flanks			
1	11:0	½" intermediate hale side	100 m/o T.B. 19.9	1400	1	0.590	0.54		
2				707	10	0.55	0.55		
3		Temp 20°C		105	50	0.56	0.54		
4				28	250	0.49	0.47		
5		½" intermediate hale side	100 m/o	7000	1	0.52	0.52		
6				670	10	0.53	0.52		
7				100	50	0.53	0.51		
8		Temp 20°C		2	250	0.51	0.50		
9	17.05	½" intermediate hale side	100 m/o T.B. 19.5°C	6000	1	1.24	1.49		
10				650	10	1.35	1.30		
11		T. 23.5°C.		100	50	1.38	1.35		
12				1	250	0.76	0.76		
13	17.10	½" intermediate hale side T. 23.5°C.	100 m/o T.B. 19.5°C	6000	1	0.99	0.89		
14				650	10	0.91	0.97		
15				100	50	0.88	0.86		
16				1	250	0.73	0.71	?	

Meter Experiments contd.

Set solution in hot water and took the resistance when the temp. had attained the steady maximum.

No.	Time	Plates	Temp. C	Bridge	Resistance	Max	T.L. (cold junc. 0°)	T.L. (cold junc. 15°)	
1	16·39	½" inlet	49°	100 ω T. 19°C.	100 ω	50	0·27	0·27	8·56
2	·47		61°				0·33	0·32	18·5
3	·53		65°				0·43	0·41	23·7
4	17·10		86°				0·88	0·86	49·8
5	·42		102				1·67	1·64	95·0
6	·52		119°				2·19	2·14	124·0
7	16·40	½" inlet	100°	100 ω T. 19°C.	100 ω	50	0·26	0·25	
8	·45		118				0·31	0·30	
9	17·10		24°				1·38	1·35	
10	·40		40°				2·07		
11	·54		46°				2·88	2·81	

* Crystals were forming just about the lowest temperature.

29th Sept. Filtered solution afresh and after doing so recovered about 470 c.c. The sp. g. by Hydr. after filtering was 1·419 @ 21·3°. Water was then added to the extent of 60 c.c. so as to retain 80% of the primitive solution and the sp. g. then was 1·395 @ 22·8°C by Hydr. 1·370 @ 23·5°C by volum.

About 5 c.c. were lost by spilling.

The lamp in the hot meter under trial was found to be extinguished in the afternoon being thereby perhaps 20 hours heat altogether.

Motor Experiments. cont.

The following readings were then taken:—

No. Obs.	Time	Plate	Bridge ft.	Rec.	Mr	Corrected for Ends of T.I.	Corr. for Ends of F.I.	λ_f ft
1	10.30	½" heated.	100 to 17.9°C.	7470	1	0.20	0.22	29.50
2		23.4°C		720	10	0.27	0.25	
3				115	50	0.26	0.25	
4				5	250	0.26	0.25	
5		½" heated. 23.4°C.	100 to 17.9°C	7000	1	0.41	0.41	23.70
6				870	10	0.44	0.41	
7				95	50	0.43	0.42	
8				1	250	0.43	0.42	
9		½" heated.	100 to 50	110	50	0.17	0.17	19.7
10			68°	-	50	1.75	1.74	201
11			26.5°	-	50	0.60	0.59	68.3
12		½" heated	100 to 58°	110	50	0.25	0.25	14.5
13				-	-	1.76	1.73	100.
14		½"	26.5°	-	-	0.72	0.70	40.5

Crystals seemed to be just about to form at this low temperature.

The area of the water between the plate is

$0.5 \times 14.25 = 0.127 \div 2 = 0.0635$ sq ft $= 1.27$ sq inches

$76 - 2.5 = 73.5$

$73.5 \div 0.0635 = 115.8$

$73.5 \div 1.27 = 57.9$

The depression has for the ½ plate risen from 14.5 to 100 for a fall of 44.2°C = 85.5 nearly .2% per °C. falling

or kept coeff. or $\frac{85.5}{44.2}$ - 16% - °C rising

or $\frac{100}{44}$

The mean temp in Meter no 1 has been about 43°C. that in - - 2 - - - 24°C a difference of 19°.
= 1% of error for $\frac{19}{4.5}$ or 4.2°C.
9°F

Meter Experiments cont. — Sunday 30th Sept (K)

Took down the meters that have been at work during the past week.
They have received current 17 hours a day for 6 days at mean rate of about 3.75 ampere = 420 ampere hours = 1,512,000 Coulomb.
So that about 1,512 Coulomb have passed through the bottles and so each Coulomb transfers 3.367×10^{-14} gms. we should expect about 0.51 gms of transfer. This will be the superior limit because for some hours the current has been cut off.

Bottle No.	Weight 23rd Sept. Single	Pair	Sum of pair	Weight 30th Sept. Single	Pair	Sum of pair	Gain	Loss
1	87.2018	175.5018	175.5025	87.6567	175.4775	175.4773	0.4549	0.4801
2	88.3007			87.8208				0.0236
3	89.4658	179.3960	179.3972	89.9576	179.4250	179.4252	0.4918	0.4638
4	89.9312			89.4676			0.0290	
5	87.9560	176.7244	176.7250	87.5139	176.7507	176.7515	0.4656	0.4621
6	88.7720			89.2376			0.0257	
7	87.9807	173.8351	173.8346	87.5330	173.8567	173.8570	0.4701	0.4477
8	85.8539			86.3240			0.0216	
				Mean loss of hot cell				0.472
								0.450
								22
								or 4.9%

It is noticeable that the bulk of the lamp rated under normally below filling 1.2 phase 5.4 which may account for the extra loss that is. The all other that some material of the insertion of the wire in the top [illegible]

Calculation for the rough conditions of transmitting 5000 H.P. from Niagara to Buffalo.

5000 HP = 3750,000 Watts. approx.
The distance is stated at 23 miles.

@ 1000 volts	this is equivalent to	3750 amperes
@ 2000	-	1875 -
@ 3000	-	1250 -
@ 4000	-	938 -
@ 5000	-	750 -
@ 6000	-	625 -
@ 7000	-	536 -
@ 8000	-	469 -
@ 9000	-	417 -
@ 10000	-	375 -

There is no great advantage therefore in exceeding 5000 volts at the Buffalo end say. Then assuming no loss in the line due to leakage we have :—

Allowing 5% loss through friction in wire

$(750)^2 r = \frac{5000}{20} = 250\,273 \times 10^{-6}\ r = \frac{250}{750} = \frac{1}{3}\omega = 0.0146$ ohms

Allowing 10%	$562500\ r = \frac{500}{750}$	$= 0.66\omega$	$= 0.0288$
- 15%	$-219\ \mu\ r =$	$= 1\omega$	$= 0.0432$
- 20%	$1092\ \mu\ r =$	$= 1.33$	$= 0.0576$
- 25%	$13.65\ \mu\ r =$	$= 1.66\omega$	$= 0.0721$
- 30%	$r =$	$= 2.0\omega$	
- 35%	$r =$	$= 2.33\omega$	
- 40%	$r =$	$= 2.66\omega$	
- 45%	$r =$	$= 3\omega$	
- 50%	$r =$	$= 3.33\omega$	

Hence allowing in the line a frictional loss of

5% requires a wire 0·33ω total res = 0·0144ω per mile = $2{\cdot}73 \times 10^{-6}$ per foot =

10% " " 0·66ω " = 0·0288ω " = $5{\cdot}46 \times 10^{-6}$ " "

15% " " 1·0ω " = 0·0432ω " = $8{\cdot}19 \times 10^{-6}$ " "

20% " " 1·33ω " = 0·0576ω " = $10{\cdot}92 \times 10^{-6}$ " "

25% " " 1·66ω " = 0·0721ω " = $13{\cdot}65 \times 10^{-6}$ " "

The largest wire usually strung overhead is #4 B.W.G. 0·238" diam. having $182{\cdot}7 \times 10^{-6}$ ω per foot so that to lose frictionally 5% would require 6¾ #4 wire

" " 10% " 3¼ " "

" " 15% " 2¾ " "

" " 20% " 1¾ " "

" " 25% " 1¾ " "

It is doubtful if the insulation could be maintained higher with ordinary telegraph insulators even the very best than 250,000ω per mile in all weathers that is 11,000ω for the whole line

With 6¾ wire this would be a total ω of 170ω

" 3¼ " " 340ω

" 2¾ " " 580ω

" 1¾ " " 650ω

" 1¾ " " 800ω

The leakage of current in the 1st case would be roughly 3½ amperes

" " " " 2nd " " " 1¾

" " " " 3rd " " " 1¼

" " " " 4th " " " ¾

At least 5% must therefore in any case be deducted from the efficiency for leakage.

Hence revised the figures stand as follow

For 10% total loss in line 4,000,000 cm 2" diam Wire or 67 ft 4 B&W wire

15%	2,000,000	1.5" diam wire	34 ft 4	
20%	1,330,000	1.15"	23 ft 4	
25%	1,000,000	1.0"	17 ft 4	
30%	800,000	0.9"	13 ft 4	

It would probably pay to employ 10 motors wound for a counter emf of 5000 volts each to deliver 500 H.P. at full load and each to transform through gearing to 200 volts and delivering at that pressure 1800 amperes.

Meter Experiments contd.

Monday 1st October :—

Recovered 489 c.c. of the 80% $ZnSO_4$ solution. Its sp. g. by Hydr: was 1.390 @ about 22°C.

Added 70 c.c. of distilled water to produce 70% solution.

The sp. g. then was:— 1.355 @ 21.6°C by Hydr
1.325 @ 24°C : balance

Tuesday 2nd October :— Sp. g. of solution 1.355 @ 25°
Tests with 70% Solution @ follows:—

No.	Plate	Time	Bridge temp.	Rev.	Ma.	TZ (c.c. for Cond. 0.34)	FZ	sp. r.
1	½" int. blued	14.05	temp. 25.5°C	7205	1	0.59	0.49	
2	Temp. 24.9°	14.10	—	675	10	0.52	0.53	
3		14.12		105	50	0.53	0.52	
4		14.13		5	250	0.49	0.49	
5	½" int. blued	14.15		6802	1	0.48	0.40	
6		14.16		652	10	0.46	0.46	
7	24.9°	14.17		100	50	0.42	0.41	
8		14.18		4	250	0.38	0.32	
9	25.8°	14.40		102	50	0.15	0.15	
10	½ -	.40½		102	50	0.25	0.24	
11	½ 24.9°	17.10		104	50	0.88	0.85	
12	½ -	..		104	50	0.71	0.70	

Unable to employ lower temperature not having ice.

Made up a new solution of 1337 grms of Wht Zinc Sulphate in 1000 c.c. of distilled water & left it to settle

Mean temp of meter under test @ 11.0 1.10.88 at 31°C sg
" - - - - - - 13.30 1.10.88 - 31°C 3.40
" - - - - - - 10.0 : : 31.5°C 3.36
" - - - - - - 14.0 : : 30°C

Back Rev. 85 Pres. 55

1.30
17.53

Front Rev. 85 Pres 55
Total H.P. 35.51

1.12
17.98

Phonograph Factory Data:

2

Set up a motor # 6 on the 29th Sept: in the Office Factory building to run the shafting there.

The conditions on Monday 1st Sept: were as follows.

Speed of Motor 1000 revs: amperes 68 volts about 100
" " shafting 200 " Diam. 38"
" " Intermediate 420 " Diam. 18" 30"
" " Blower 2400 " " 9"
Pressure in cupola under load 6 oz: Water:

Took Diagrams of power given by engine when motor not running and the mean was about 33 H.P., two diagrams being appended.

Meter Experiments contd.

Tuesday 2nd October.

Made up a solution as mentioned on p 1 of 1337 grms $ZnSO_4$ + 1000 water.

Wednesday 3rd October

The solution having free crystals of $ZnSO_4$ added 100 c.c. H_2O dist.

Temp. of Not meter above cool 16.2°C. @ 18.0. 2.10.18

Discovered on the morning of the 4th Oct. that the meter test was useless owing to a mistake in the connection. Took it down and reset it. Cleaned and remelgamated plates weighed as follows 88.10.5. 16-18.

Plate	Weight	Paper	Weight of plate	Sum of pairs	Weight of couple	Weight of one plate	Diff
1	87.5837	0.7386	86.8451	174.3970	175.1369	174.3985	0.00084
2	88.2910		87.5524				
3	90.7968		90.0582	178.0894	178.8293	178.0907	0.0013+
4	88.7698		88.0312				
5	92.4444		91.7028	182.0906	182.8292	182.0921	0.0000
6	91.1264		90.3878				
7	88.6255		87.8869	175.8562	176.5938	175.8552	0.0010
8	88.7079		87.9693				

Meter Experiments cont. –

October 3rd.

Sp. g. of 70% solution last used after filtration 1·355 @ 20·1°C by Hyd.

Amount 528 cc

Added 93 cc. of distilled water to reduce to 60%

Sp. g. of 60% solution as made 1·322 @ 20·8° by Hyd.
1·286 @ 26°C – below

Sp. g. of distilled water by balance 0·9985 @ 22·5°C.
correction for thermometer fully – 2·5°

Took following series after remelgamating roomsifice

No.	Time	Platu Temp	Bridge 1/2	Res.	Mes	T.I. with per cent 0·24	F.I.
1	14·58	½° 21°C	22·5° 1000/10	7400	1	0·31	0·26
2	15·00	-	-	720	10	0·265	0·25
3	15·01	-	-	1145	50	0·26	0·255
4	15·03	-	-	·3	250	0·26	0·253
5	15·05	½° 21°	-	6400	·1	0·446	0·446
6	·06	-	-	650	10	0·446	0·438
7	·07	-	-	100	50	0·446	0·438
8	·09	-	-	2	250	0·446	0·43
9	·30	½ 53·2°	-	94	50	0·20	0·19
10	·31	½ 53·3°	-	"	-	0·12	0·11
11	16·28	¼ 4·8°	-	-	-	1·71	1·71
12	·30	½ 4·4°	-	-	-	1·66	1·62

Crystal just forming at the low temperature.

Motor boat south –
Thursday 21st October.
Recovered after filtration 500 odd c.c. sp.g. 1·3250 @ 18·5°
by Hydr.
added 100 c.c. of distilled water to reduce to 50%.
sp.g. then by Hydr. 1·255 @ 18·9°C
balance 1·2474 @ 19·5°C.

Took following series, after reamalgamating and revarnishing plates.

No.	Time	Plate	Purity	Res.	Mag.	F.Z.	F.Z.	
1	14.15	½" 19.5	100%	7500	1	0.41	0.39	
2	.16		.19.2C	720	10	0.39	0.37	
3	.17			111	50	0.39	0.37	
4	.20			5	250	0.35	0.34	
5	.22	½ 19.5		7200	1	0.55	0.49	
6	.23			720	10	0.51	0.49	
7	.25			105	50	0.50	0.49	
8	.26			2	250	0.48	0.48	
	In heating this solution the teacher broke and solution lost. Made new solution.							
9	14.51	½ 19.5	100% 20.3C	7200	1	0.50	0.50	
10	.52			700	10	0.67	0.67	
11	.55			110	50	0.67	0.66	
12	.56			5	250	0.61	0.60	
13	.59	½ 19.5'		6000	1	0.45	0.45	
14	16.00			650	10	0.43	0.42	
15	.01			100	50	0.43	0.41	
16	17.02			10.0	250	0.37	0.34	
17	.30	½ 49.1		92	50	0.14	0.13	
18	.34	½ 48.8'		4	"	0.26	6.25	
19	.40	½ 3.8'		"	-	1.57	1.55	
20	.41	½ 3.9'		"	-	1.14	1.14.	

Bacteria Experiments

September 28th

Subjected a solution of pepsin in common water to a temp. of 23-25° C. One drop of this solution was observed to contain microbes. After examination added one drop of a 6.5% sol. NaHO. After the addition no movement could be discerned.

Another drop of the same pepsin solution was observed to contain moving microbes. Added one drop of gasolene after which no movement was discerned.

A drop of solution of egg (that had been breeding for some time) was observed to contain moving microbes. After the addition of one drop of 6.5% sol. NaHO to the slide, no movement was observed.

Took a square meter of slightly inclined ground in the courtyard, and marked off inside it and symmetrically a square of 45 cms. Poured evenly over the surface of the center square about 2000 cc of gasolene, and immediately afterward poured 60000 cc of common water over the whole square meter with a sprinkler. Next after the lapse of one hour removed with a trowel a section of area 5 cm X 12.5 cm. and from

the surface to a depth of 23·5 cm.

On making chemical analysis of the filtrate from this quantity of earth found about 12·5 % of the original strength of solution (including the $NaClO_3$).

Sept. 29th. Captured a fly (commonly called Daddy Longlegs) and placed it inside an evaporating dish. About 1 cc of gasoline in a separate small vessel was introduced into the inverted evaporating dish as also a caterpillar. These animals were thereafter left exposed to the gasoline vapor. The fly died apparently in about 3 mins. the caterpillar in about 2 hours. (5 mins. 20 secs.)

Oct. 2nd. Took a battery jar, & filled it with well settled red fine sand. Poured over the surface the following amount of $NaClO$ 44·2 c.c. = 0·20 gm. by sp. g. of solution by balance = 1·066. This was poured on at 11 o'clock.

Tested this sand after it had remained untouched in the open air for 4 hours. Took a central section by means of a glass tube and then divided this sectional shaft of sand into upper, lower and middle thirds. The top had 16 c.c. of earth, the middle 8 and the bottom 15. Found by chemical analysis that 72 % of the quantity supposed to have been poured on the test area was present in the upper third, none in the lower or middle.

Took a glass tube 175 cms long and 5 cms in int: diam. At the lower end this was drawn down to a 2 cm diam circular opening, and a plug of cotton waste there inserted reaching about 5 cms into the tube. Prepared some white sand by thoroughly washing it and drying it in a sand bath. Filled the tube with this dry white sand to within 30 cms of the top thus retaining a column 1140 cms long. Poured over the top of the column in the vertically held tube 713 cc of NaHO solution 6·5%. This rapidly descended the column as the colour evidenced the rate being about 0·22 cms per sec: at outset. The liquid was collected as it ~~was~~ filtered through in a bottle beneath, and the filtrate tested. It was found to be a 6·2% solution and consequently to have only lost about 5% of the original strength. The experiment lasted 3 hrs + 30 mins.

Set a small copper water bath over a kerosene lamp chimney to work at 18·0

2.10.88 with 5 beakers in it

no 1 contained solution of ——— in common water.
(2) – – – papain – –
(3) – – – CaO – –
(4) – – – $NaCl$ – –
(5) – – – $NaHO$ – –

Bacterio Observations.

October 4th. Temp. of nest 27°C.
after 18 hrs. - - - 23°C.
- 41 - - - 27°C.

The duckmeat was not introduced till after the 41st hour.

Pepsin solution was observed to contain both microococci and bacteria.

One drop of this solution adulterated with one drop of HgCl₂ 1/1000 showed no movement after an hour. Perhaps dried?

Repeated experiment under exactly same conditions but observed life after 15 mins.

Repeated experiment adulterating with one drop of 1/1000 HgCl₂. After 30 mins. life was still viable.

Repeated experiment adulterating with one drop of 1% HgCl₂ after some time life was still viable.

Repeated experiment adulterating with one drop of concentrated ordinary solution of HgCl₂. Life was still viable.

These results being so anomalous tested the HgCl₂ solution found that it probably contained an oxychloride of mercury from absence of acidity. Made up a new solution rendered slightly acid by HCl.

On repeating last adulterating with one drop of concentrated solution. Found it killed

Microbes. Experiments

October 4th.

Placed a little black snake about 10 cms long) under a goodsized evaporating dish with about 10 cc. of gasolene in a small phial. Death was produced in about 30 minutes.

October 5th.

Took one drop of pepsin solution and finding life in it adulterated with 1 drop of $HgCl_2$ new solution $\frac{1}{1000}$. No movement then perceived.

Repeated experiment with same result.

Tried several ~~drops~~ minute of pepsin solution drops adulterated with $ZnCl_2$ concentrated. So far as could be discerned this did not kill microbes.

Two tests with chromic acid in the same way $\frac{1}{500}$ + $\frac{1}{1,000}$ seemed to kill microbes.

One test with gasolene one drop of gasolene to four of pepsin solution seemed to show that the movement of the bacteria ceased but the smaller micrococci seemed to show movement.

One test with NaHO solution concentrated 6.5% solution did not seem to kill either the larger or the smaller.

Temp: of rest 28° C.

Meter Tests cont'd —

Betrip 4.4

Recovered after filtration 480 c.c. of 50% sol. sp. g. 1.268 @ 16.9 by B. Hydr.

Added 120 c.c. of H_2O dist. to reduce this to 40% sol. The sp. g. then being 1.18444 @ 18.2°C by balance

1.225 @ 16.6°C. B. Hydr.

Made following measurements with this solution.

No of Obs.	Time	Plate	Bridge	Res	Mes	Converted to Case 2 25 F.L.		Sp. c.
1	9.43	½" 4.8°	100% sp. g. 22°C	7400	1	0.70	0.50	
2	.46			725	10	0.50	0.47	
3	.47			110	50	0.48	0.47	
4	.48			3	250	0.47	0.46	
5	.50	½" 4.8°		6800	1	0.70	0.25	
6	.51			675	10	0.45	0.28	
7	.53			105	50	0.30	0.28	
8	.55			2	250	0.28	0.27	
9	10.12	½ 48.8°		110	50	0.25	0.24	
10	.14	½ -		110	50	0.17	0.17	
		Breakers have been made over solution						
11	13.26	½ 20.8°	22.5°	7400	1	0.50	0.50	
12	.27			700	10	0.52	0.50	
13	.28			110	50	0.51	0.50	
14	.30			4	250	0.51	0.50	
15	.32	½" 20.8°	"	6050	1	0.55	0.25	
16	.33			620	10	0.32	0.28	
17	.34			104	50	0.31	0.29	
18	.35			0	250	0.28	0.26	
19	14.10	½" 48.1°		92	50	0.34	0.14	
20	.11	½" 47.5°		"	"	0.24	0.23	
21	15.27	½ 2.5°		"	"	1.11	1.09	
22	.28	½" 2.5°		"	"	0.76	0.75	

Meter Experiments contd:—

The solution employed after the fracture of the beaker mentioned on the preceding page was:— 80 c.c. of solution 40% left in bottle replenished with 160 c.c. of concentrated Wilmotts pure H_2SO_4 and 240 H_2O. The density being 1.170 @ 22.0°C by balance.

October 5th Saturday:—

Recovered after filtration 467 c.c. of 40% solution. Added to this 156 c.c. of distilled water making 623 c.c. of 30% strength. Before the addition of the H_2O the sp. g. was 1.225 @ 21°C by B. Hyd.
after the addition . . . 1.140 @ 21.6° " Hyd. sp. g.
1.140 @ 22.5°C . Balance

Took following series

No.	Time	Photo Temp	Bridge	Res.	Mu	Not for tests 2 & 3 T.E.	FE
1	14.46	½° 21.5°	100%	7400	1	0.50	0.50
2	.47			700	10	0.49	0.48
3	.48			115	50	0.49	0.48
4	.50			5	250	0.48	0.48
5	.52	½° 21.5		6900	1	0.38	0.30
6	.53			750	10	0.29	0.28
7	.54			110	50	0.28	0.28
8	.55			3	250	0.28	0.27
9	15.10	½° 52.0		112	50	0.15	0.15
10	.12	½° 52.7		112	50	0.28	0.27
11	.58	½° 40.0°		112	50	0.37	1.35
12	16.00	½° 39.9°		112	50	1.25	1.24

Meter Experiments contd:—

October 5th Friday.

Took the Resistance with Mr Wirt of the 4 12 light and also of the 4—25 light meter batteries in series which have been left standing untouched since the 13th September — a lapse of 22 days see No V p. 40. Results as follows:—

Reading No.	Time	Number of Minutes after commencement	Bridge	Resistance	Mass	Battery	Corrected for Capacity F.Z. T.Z.	F.Z.	Mean Resistance per Tube
1	10·50	0	100%	7000	1	4-12 lt. 21·0	75·75		19·7
2	·55	5	-	-	-		72·75		18·2
3	11·00	10	-	-	-	- -	71·75		17·9
4	·05	15	-	-	-	- -	67·75		16·9
5	·08	18	-	-	-	-	66·75		16·7
6	·09	19	-	-	-	2 batts only on circuit	30·25		15·1
7	·10	20	-	-	-	4 batts open	66·25		16·6
8	·15	25	-	-	-	-	64·75		16·2
9	·20	30	-	-	-	- -	62·75		15·7
10	·25	35	-	-	-	-	61·25		15·3
11	·35	45	-	-	-	-	59·25		14·8
12	·45	55	-	-	-	-	57·75		14·2
13	12·00	70	-	-	-	-	54·25		13·6
14	13·20	150	-	-	-	-	45·05		11·26
15			-	-	-	4 25 lt batts 21·0	52·75		13·2
16				0	250		9·25		2·31

Meter Experiment cont. –

October 8th Friday

Took the plates which looked clean but much rubbed out of the bottles used in the last test and thoroughly cleaned them. They were then reamalgamated, remounted and set up again. The density of the solution in the bottles was tested and found to be slightly in excess of 1.0446.

These bottles were then connected as before in series. i.e. {4 12-light bottles} and the following measurement made 4 25 . . .

No of ch.	Time	Bottle Temp.	Bridge	Resist.	Mass	Deflect for T.Z.	Deflect F.Z.	Mass per bottle T.Z.	
1	16.50	4.4 to 2.0	100 m/m	7000	1	10.45	10.25	2.61	
2				1500	5	10.45	10.25	2.61	
3				700	10	10.44	10.25	2.61	
4				310	20	10.40	10.15	2.60	
5				10	250	9.80	9.15	2.33	
6	17.50	4.2 to 2.0	100 m/m	7000	1	5.25	not det.	1.31	
7				310	20	5.25	–	1.31	
8				0	250	5.07	–	1.26	

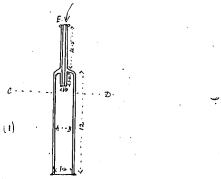
The bottles were then left in the showroom without current (disconnected) for future tests.

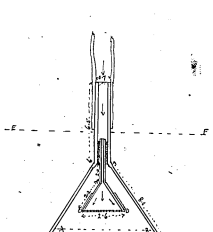
Resumé of Specific Res: Measurements of various $ZnSO_4$ solution densities to date.

No. of Expt.	Date 1906.	Solution used	Sp. g.	Res. 4 T.Z. of (init. 1/16") plate			Res. 6 T.Z. of (init. 1/8") plate			
				Res. in equilibrium at 25°C.	Res. at entire immersion	Res. in equilibrium at 45°C.	Res. in equilibrium at 25°C.	Res. at entire immersion	Res. in equilibrium at 45°C.	
1	9/05	100%	1·143	0·[illegible]0 ± 0·[illegible]	0·[illegible]0 ± 0·[illegible]	1·13 ± 0·7°	0·32 ± 0·05°	0·246 ± 0·00°	0·232 ± 7·0°	
2	9·28	90%	1·205	0·[illegible]0 ± 0·[illegible]	0·[illegible]0 ± 0·[illegible]	2·18 ± 0·4°	0·90 ± 0·25°	0·270 ± 0·00°	2·19 ± 0·4°	?
3	9·29	80%	1·370	0·37 ± 0·[illegible]	0·37 ± 0·[illegible]	1·720 ± 0·8°	0·240 ± 0·22°	0·230 ± 0·00°	1·76 ± 0·5°	
4	10·1	70%	1·325	0·42 ± 0·[illegible]	0·15 ± 0·[illegible]	—	0·230 ± 0·22°	0·230 ± 0·01°	—	
5	10·3	60%	1·286	0·26 ± 0·2°	0·12 ± 0·33°	1·11 ± 0·5°	0·240 ± 0·21°	0·230 ± 0·02°	1·66 ± 0·[illegible]	
6	10·12	50%	1·247	0·240 ± 0·[illegible]	0·[illegible] ± 0·[illegible]	1·14 ± 3·3°	0·270 ± 0·18°	0·260 ± 0·16°	1·570 ± 3·5°	
7	10·5	40%	1·184	0·310 ± 0·[illegible]	0·[illegible] ± 0·[illegible]	0·75 ± 2·5°	0·310 ± 0·20°	0·240 ± 0·02°	1·11 ± 2·7°	
8	10·6	30%	1·140	0·330 ± 0·[illegible]	0·150 ± 0·10°	0·35 ± 0·29°	0·290 ± 0·22°	0·250 ± 0·02°	1·370 ± 6·0°	
9	10·8	20%	1·096	0·315 ± 0·[illegible]	0·170 ± 0·11°	1·405 ± 0·6°	0·89 ± 0·20°	0·370 ± 0·01°	2·11 ± 0·5°	
10	10·9	10%	1·050	[illegible]	[illegible]	[illegible]	1·07 ± 0·43°	0·460 ± 0·02°	2·60 ± 0·6°	
11	10·9	5%	1·017	[illegible]			3·00 ± 0·2°	1·12 ± 0·02°	2·16 ± 0·8°	

The small subscript figures are the deduction for contact resistance at the surfaces of the plate made from the two sets of observations and calculated from the formulae

$$\left.\begin{aligned} r_{\frac{1}{2}} &= x + y \\ r_{\frac{1}{4}} &= 2x + y \end{aligned}\right\} \therefore \; x = r_{\frac{1}{2}} - r_{\frac{1}{4}}.$$





Gasolene: Experiments :-

Tried the following experiment to see if the gas dissolved by water could be mechanically evolved by passage through gasolene.

A test-tube had a tube blown into its closed end as shown. The test-tube was fully filled with gasolene; i.e. from the shoulder to the dotted line AB. and water filled the rest of it, which it stood in a vessel of water up to about the level CD. A caoutchouc tube fixed on the lip at E allowed a water supply to be forced slowly in the direction of the arrow drop by drop through the tube and down through the gasolene. If any gas were disengaged it would thus be allowed to accumulate under the shoulder of the test-tube. No such gas was ever bubbled disengaged. Each drop took with it its self contained air.

Arrangements were therefore made to more finely subdivide the water in its passage through the gasolene, and the apparatus in fig 2 was used. The outer glass funnel was full of gasolene to the depth AB from the shoulder, and was submerged in water up to about the level EF, water being below the level AB. The small glass funnel was sealed into the neck of the large one and was closed at its mouth by a thin sheet of lead pierced with numerous pinholes so as to form a rose sprinkle. By means of a caoutchouc tube above, water was forced down through the gasolene. The water was not properly separated but was better divided than in the first experiment. Bubbles of gas did rise from the liquid above the layer AB. and after forcing through some 10 litres of water through the apparatus about 1·5 c.c. of gas collected in the shoulder. An attempt was made to test this gas as possible. A moist Pyro test showed no fall, but not sufficient

Meter Experiments contd :—

October 8th. Monday)

Collected 500 c.c. of 30% solution. sp. g. 1.158 @ 19.4°c by Hydr.
Added 250 c.c. of H_2O dest.
and obtained 750 c.c. of 20% solution.
sp. g. of 20% sol: 1.096 @ 20°c by balance
1.0965 @ 20.7°c - Hydr.

No. of obs.	Time	Plates	Bridge	Peak	Mn	corrected for leakage T.I.	for leakage F.I.	
		Temp						
1	11.27	½ 26.5°	100% 20.1°c	7400	1	0.461	0.31	
2	.30			710	10	0.30	0.28	
3	.37			130	50	0.315	0.30	
4	.39			.2	250	0.315	0.305	
5	.41	½ "		6400	1	0.57	0.57	
6	.42			670	10	0.59	0.58	
7	.43			100	50	0.59	0.57	
8	.45			0	250	0.58	0.57	
9	13.38	½ 51°		110	50	0.37	0.36	
10	.41	½ "		-	-	0.19	0.19	
11	.45	½ 45°		-	-	1.405	1.42	
12	.46	½ 45°		-	-	2.17	2.12	

Voltmeter Observations

1417 on Park circuit indicating 8 in excess
1416 - - - - correctly
1793 - Phonograph - - 3 in excess.

Phonograph Factory Blower Trials.

(October 8th Monday).

The motor at the Factory is so geared that when its armature makes 1000 revs per min, the line of shafting makes 200. Then the pulleys on the shaft for driving the blower being 38" diam those on the ~~intermediate~~ shaft 18" and 30" respectively, that on the blower 5½" we have for 200 revs. of shafting

$$200 \times \frac{38}{18} \times \frac{30}{5\frac{1}{2}} = 2300 \text{ revs. per min.}$$

The pipe connecting the cupola with the furnace is 9" in diam so that it has an area of 63.6 sq. in.

A shutter slide was arranged in a box fitted into the pipe so as to give a variable aperture. The breadth of the opening so made was measured and is given in the following series. The width of the shutter is so that an opening 5" wide corresponds to an aperture of sq. in.

Current in motor at. amperes	Estimated rotary speed at revs per min	H.P. absorbed by motor	Speed of blower r.p.m.	Width of shutter opening	Volume under maximum pressure	Pressure mm sq. in.
50	185	7.85	2650	closed	13"	7.53
65	"	9.17	"	1"	12½	7.24
75	"	10.58	"	2"	11"	6.37
80	"	11.28	"	3"	9⅝	5.36
93	"	13.11	"	4"	8"	4.63
95	"	13.40	"	5"	6⅞	3.98
110	"	15.51½	"	all open	–	

Record of blast pressures at Phonograph Works (2)
on the occasion of the first blast at casting.

No.	Time	Amplitude on standard	Estimated lbs absorbed by Meter	Slit	Mean pressure lbs per sq. yd. in chamber	Mean pressure in lbs per sq. yd. from Meter
1	12.43	62	8.74	open	7.8	7.82
2	.48	65	9.17		7.8	8.40
3	.50	64	9.02		7.8	8.45
4	.54	64	9.02		7.8	8.28
5	.57	63	8.88		7.7	8.28
6	13.00	61	8.60		7.7	8.28
7	.03	60	8.46		7.7	8.28
8	.06	59	8.32		7.7	8.22
9	.10	58	8.18		7.7	8.22
10	.13	58	8.18		7.6	8.22
11	.15	59	8.32		7.75	8.16
12	.18	62	8.74		7.5	8.04
13	.20	62	8.74		7.5	8.04
14	.25	62	8.74		7.8	8.51
15	.28	66	9.31		8.6	9.55
16	.30	65	9.02		9.2	9.55
17	.32	64	9.02		9.2	9.50
18	.36	64	9.02		9.1	9.50
19	.45	64	9.02		9.0	9.55
20	.48	64	9.02		9.0	9.55
21	.52	63	8.88		9.1	9.55
22	.55	62	8.74		9.1	9.50
23	.57	62	8.74		9.0	9.50
24	14.02	62	8.74		9.0	9.15
25	.05	70	8.87		8.0	9.55
26	.09	62	8.74		9.1	9.55
27	.14	63	8.88		9.1	9.55
28	.19	62	8.74		9.1	9.55
29	.25	63	8.88		9.1	9.50
30	.30	63	8.88		9.0	9.44

Meter Experiments cont

October 8th Monday

Took Resistance of the 4 12 lt + 25 lt batteries made up on the 7th inst. Kept a current of 1 ma passing through them in order to find how resistance fell.

No. of obs.	Time	Plates	Bridge	Res. in ohms	Ma	Deflections T.Z.	Deflections F.Z.	T.Z. per bottle
1	16·03	4 · 12 lt bottles Temp 21°C	1000 ~	7450	1	16·14	15·84	4·035
2	·10					16·23		4·06
3	·15					16·23		4·06
4	·20					16·23		4·06
5	·25					16·16		4·04
6	·30					16·16		4·04
7	·35					16·12		4·03
8	·40					16·08		4·02
9	·45					16·04		4·01
10	·50					16·02		4·01
11	·55					15·99		4·00
12	17·04					16·96		3·99
13	·05			100	50	11·16	10·74	2·79
14	·07			0	200	9·29	8·99	2·32
15	·10	4 25 lt bottles Temp 21°	1000 ~	6670	1	9·14	8·84	2·28
16	·15					9·29		2·32
17	·20					9·27		2·32
18	·25					9·23		2·31
19	·30					9·16		2·29
20	·35					9·14		2·29
21	·40					9·13		2·28
22	·45					9·09		2·27
23	·50					9·09		2·27
24	·52			100	50	6·29	6·04	1·67
25	·56			0	200	5·25	5·020	1·31

Motor Experiments contin.

October 9th Tuesday :—

Took 500 c.c. of the last or 20% $ZnSO_4$ solution whose sp. g. was found to be 1.100 @ 17°C by Hyde and added 500 c.c. of H_2O dist. to reduce it to 10% solution.

It then had a sp. gr. of 1.0515 @ 19.7°C by Hyde + 1.0468 @ 21.5°C - balance.

Took following measurements :—

No. of Ds	Time	Plate	Bridge	Res. in mf	Mac	cells for Time T.Z.	cells for Time F.Z.	
1	13.50	¼"	19.5	100 fm 19.4°C.	7400	1	2.99	2.69
2	·51				700	10	2.65	2.59
3	·52				100	50	1.93	1.86
4	·53				2	250	1.04	0.99
5	·56	½"			6200	1	1.04	1.02
6	·57				650	10	1.07	1.06
7	·58				100	50	1.07	1.04
8	·59				0	250	1.00	0.98
9	15.00	¼"	47.5		100	50	0.63	0.63
10	·58		46		100	50	2.66	2.59

One of the wires attached to the ½" zinc plate was found quite loose and this together with the obviously unreliable reading obtained from these plates rendered it necessary to dispense with them.

Collected 300 c.c. of this solution whose sp. g. was observed to be 1.055 @ 11.0°C by Hyde and added 300 c.c. of H_2O dist. to reduce it to 5% solution. The sp. g. was then by balance 1.017. In testing this solution, the polarization was very decided, but was certainly less at the higher than at the lower temperature.

Motor Experiments cont.

No.	Time	Plates	Bri.	Res.	Mag.	coll. for F.Z.	Rada. F.Z.	
1	16.22	½" 20°	100 fc. 2.6	7400	1	10.74	10.74	
2	.23			700	10	6.59	6.04	
3	.26			112	50	3.04	2.84	
4	.28			0	250	1.91	1.84	
5	17.20	47°		0	250	0.99	0.96	
6				100	50	1.03	0.96	
7				700	10	1.12	0.97	
8				7400	1	1.44	0.99	
9	18.03	5.8°		7400	1	7.74	7.74	
10				700	10	6.54	6.04	
11				100	50	3.16	3.01	
12				0	250	2.41	2.26	

Arc Experiments, made with Mr Wirt

October 10th Wednesday

Took two wires connecting 48 Edison lamps to the 111 volt circuit and obtained between them in air an arc of as much as 1" when the + wire was supposed to be above, and as much as ½" when the + wire was supposed to be below. ?

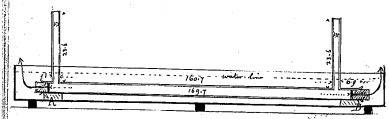
On pressing the ends of these two wires together on a fireclay cylinder and then drawing them apart, arcs 1" long were reached.

On pressing the ends similarly on a damp red brick, arcs ½" long were obtained.

On pressing the ends similarly on glass plate, arcs of over an inch perhaps ½ were obtained, the arc in each case fracturing the glass.

On pressing the ends similarly upon the glazed surface of a white clay fuse piece box, arcs of over one inch were obtained. The average being about one inch.

On removing the glaze at one side of the ring with an emery wheel + again) the unglazed smooth surface, superficially, the arcs obtained were as much as 3/16" the average being about ½".



Int. Diam.	at + mean A.	1·027" = 2·61 cms	Mean	5·350
" "	" B	1·076" = 2·73 "		5·854
			Mean	5·602
Ext. "	" A	1·206" = 3·06 "		
"	25 cms from outer of tube	1·213" = 3·08 "		
"	50 " "	1·222" = 3·10 "		
"	75 " "	1·235" = 3·14 "		
"	100 " "	1·229" = 3·12 "		
"	125 " "	1·226" = 3·11 "		
"	150 " "	1·252" = 3·18 "		

$$\frac{5.602}{169.7} = \frac{5.602}{1.697} \times 10^{-2} = 3.301 \times 10^{-2}$$

Meter Experiment contd:—

October 10th Wednesday

Made up the following apparatus to measure the sp. gr. of $ZnSO_4$ solution.

A glass tube 172·5 cms long and 2·61 cms in diam: cut at one end 2·73 cms at the other: had corks inserted into its ends. These corks were each faced with disks of zinc 2·5 cms in diam: and about 0·1 thick, connected to the measuring apparatus by rubber covered wires soldered to their backs which wires passed through the corks. Two smaller tubes were blown into the larger one at near the ends as shewn and they served for insertion of thermometers and for shaft to pour in and out the tested solution.

The whole tube was immersed in a zinc trough 182·5 long 10 broad + 10 deep of ⊔ cross section. This trough was filled with ~~the~~ water at the ordinary temperature, then with hot water and then with ice + water well stirred. The readings were taken when the thermometers at A and B were in accordance.

The small zinc disks were amalgamated before use.

Took the solution composed of 1337 grms $ZnSO_4$ salt + 1100 H_2O dist. and filtered it.

Its sp. g. was then by Beaumé Hydr 1·415 @ 18°C
" " Balance 1·396 @ 20°C.

The Two Thermometers were compared by setting them in the same vessel the Zero Therm. gave 19·3°
" 6° " " 19·6°.

Took the 50 gramme bottle which seemed to be a milligramme short of its empty) counterpoise and filled it with some of this solution. It gained 6 g.798 grammes @ 20°.c.

50 grammes of air at 20°.c weigh $\frac{273}{293} \times 50 \times 1.276$ grm $= \frac{273}{293} \times 638 = 59.4$ so that the weight of liquid would be 66.857 which exceeds 50 by 16.857 and ~~was 13.9~~ 13.9 which $= 1.3971$ = sp. g. 1.397.

Evaporated this liquid

Weight of evaporating dish 80.528

" " " " and anhydrous residue 103.05.

" " anhydrous In_2SO_4 evaporates 22.52 grm

There are therefore 22.52 grammes of anhydrous salt in solution of 27.48 grammes of water. As in evaporation some little explosion of bubbles took place with a slight scattering of salt there may have been more than this. 45.4 %

No	Time	Bridge	Nominal	Mass from tables	Mass. the tube	Corrected for tube T. Z.	Corrected for tube F Z	sp. v.	Temp A	Temp B
1	11.23	1000/1000 T.B 26°C	7000	1	0.9	6504.4	6487.7	21.44	21.6	21.6
2	.25		900	5	4.5	6509.9	650.5	21.5		
3	.26		50	10	.9	651.7	651.2	21.5		
4	.27		0	10.5	9.6	652.6	652.1	21.52		
5	.28		7000	1	0.9	654.7	652.7	21.54		
6	13.42		0	16	14.5	353.7	353.7	11.44	49.2	49.0
7	43		7000	1	0.9	359.7	357.7	11.80		
8	14.25	1000/1000	7000	1	0.5	1141.7	1139.7	37.61	56.6	56.2
9	.26		450	5	2.5	1145.7	1145.7	37.82		
10	.26		0	7	3.5	1145.7	1145.7	37.82		
11	.45		0	7	3.5	1029.7	1029.7	33.96	49.8	50
12	15.14	1000/1000	0	10	9.8	835.7	835.7	27.56	48.3	48.2
13	16.42		0	10	9.1	759.7	749.7	24.74	47.6	47.8

$\frac{5.677}{1697}$ .3227

Assuming that

$$a + bt + ct^2 = \rho$$

$$a = +43.15$$

$$b = -1.323$$

$$c = +0.0138$$

Meter Experiments contd.

October 10th Wednesday

Took the resistance of two samples of iron wire bought by M Wirt.

A The first was 577 cms long and #20 0.035" = 0.0889 cm

B - second 433 - - #27 0.016" = 0.0406 cm

The area of the 1st (A) wire thus 6.207×10^{-3}

2nd (B) - 1.295×10^{-3}

The resistances were

	Res.	Leads	corrd.	Temp.	Sp. r.
A	~~1.235~~ 1.235	0.220	1.015	20°C.	1.092×10^{-5}
	~~1.224~~ 1.204	0.220	0.984	11.1°	1.059×10^{-5}
	~~1.224~~ 1.275	0.220	1.055	30°	1.135×10^{-5}
B	4.870	0.220	4.650	20°C.	1.395×10^{-5}
	4.524	0.220	4.304	11.5°C	1.291×10^{-5}
	5.090	0.220	4.870	30°C.	1.461×10^{-5}

$$\frac{6.207 \times 10^{-3}}{5.77 \times 10^{2}} = 1.076 \times 10^{-5}$$

$$\frac{1.295 \times 10^{-3}}{4.33 \times 10^{2}} = 3 \times 10^{-6}$$

∴ A's coefficient

	Change between		Diff. Temp.	% resistance	% per °C
	11.1 + 20°		8.9°		
	0.031	in	8.9°	3.15	0.354
Between 20+30	0.040	in	10°	3.94	0.394
	11.1 + 30	0.071	18.9°	7.21	0.382

B's coefficient

Between	11.1 + 20				
	0.346	in	8.5°	8.04	0.945
	0.220	in	10°	4.73	0.473
	0.566	in	18.5	13.15	0.716

A was supposed to be nearly pure iron but a little brittle

Specific Gravity Measurements :—

October 11th Thursday

Took a solution (nearly) concentrated) of $ZnSO_4$ in H_2O dist. + compared the readings of three different sp. g. instruments in it, as follows :—

No. of Test	Sp. g. by balance	Temp. solution	Sp. g. by Beaume	Error of Beaume	Sp. g. by Hydr.	Error of Sp. g. Hydr.	
1	1.418	23.3°	—	—	1.41	− 0.008	
2	1.310	23.8°	1.355	+ 0.045	1.30	− 0.010	
3	1.195	23.5°	1.245	+ 0.050	1.180	− 0.015	
4	1.171	24°	1.205	+ 0.034	1.160	− 0.011	
5	1.120	23.5°	1.150	+ 0.030	1.120	− 0.000	
6	1.091	23.3°	1.120	+ 0.029	1.090	− 0.001	
7	1.061	23.1°	1.080	+ 0.019	1.060	− 0.001	
8	1.031	22.5°	1.040	+ 0.009	1.030	− 0.001	

From these results the errors of the Hydrometers are

Greiner Aerometer		Greiner Cmp. Hydr.	
Between sp. g. as indicated by inst.	Error	Between sp. g. as indicated by inst.	Error
1.000 and 1.050	+ 0.010	1.000 and 1.120	− 0.001
1.050 " 1.080	+ 0.015	1.120 " 1.41	− 0.010
1.080 " 1.150	+ 0.025		
1.150 " 1.200	+ 0.030		
1.200 " 1.250	+ 0.040		
1.250 " 1.350	+ 0.045		

Contents of tube

p 1	g 26	3.5	12.25	12.25
" 2	g 30	0.5	0.25	0.50
" 2	g 32.5	3.0	9.0	18.0
	88.5			Σ p² 30.75
	g 29.5			

$$0.67645\sqrt{\frac{30.75}{2}} = 0.67645\sqrt{30.75} = 0.67645 \times 5.54$$

$= 2.6642$ P.Er. of Ob. wt 1.

P.E of Mean $= \frac{2.6642}{\sqrt{8}} = 1.18$

Meter Measurement:—
October 11th Thursday

Took two specific resistance measurements with the long tube, the first with corks in the ends as in "the trial recorded on page 31. It was found however that these corks did not keep perfectly watertight, although the resistance was not affected, troublesome loss of solution occurred. In the second experiment therefore the corks were replaced by rubber stoppers with hole pierced admitting the rubber covered wire tightly. No further trouble on the score of leakage was then appreciated.

The sp.g. of the orig. sol. was 1.396 by Balance @ 20°C
" " " " " 1.397 by sp. g. bottle.

This corresponds to 55% solution by tables. and its composition (137 gms $ZnSO_4$ to 100 H_2O) makes the amount 54.96%

Collected of this solution 990 c.c. of sp.g. 1.396. of which 49 g would presumably be $ZnSO_4$

Added 100 c.c. of H_2O making the total 1000 c.c. and reducing the % of salt to 49.5 or 90% of orig. strength. The sp. g. of this solution after filtering was 1.360 by Balance @ 20.5°C.
1.385 " Hydr. @ 19.1°C calc = 1.3440

Collected of this solution 920 c.c. of sp.g. 1.3820 = 1405 gs of which 45 g. 4 c.c. were presumably $ZnSO_4$ added 1240 c.c. of H_2O dist. making 1014 c.c. or a 44.6% solution. 80% of original strength. The sp.g. of this after filtration was { 1.318 @ 24.°C by Balance
1.355 @ 16.2°C by Hydr. = 1.3140

The tube when filled with rubber stoppers was observed to hold up to the base of the shafts 929 c.c. @ 19.1°C

Inter Electrode dist. 16 g.0
Clearance .5
16 g.5

929.5 ÷ 16 g.5 = 5.4844 top volume
5.602 bottom
5.5443

$\frac{A \times 5.5443}{16 g.0} = 0.0328$ A $= 3.28 \times 10^{-2}$

$\frac{5477}{16 g.} = .3241$

From the 90°F. values
a = +37.75
b = −1.089
c = + 0.0118

Assuming that $a + bt + ct^2 = \rho$
we have
a = + 35.22
b = − 0.903
c = + 0.00795

Meter Experiments contd. —

October 11th Thursday.

Took following readings on the columns of solution 90°F. 80°F. orig. strength mentioned on preceding page. Twice electrodes freshly amalgamated

No. of Obs.	Time	Solution temp	Resistance est.	Mass for letting	Mass to tube	I X calc for tube 0.36	F.X.	5.444 of mass
1	10.20	90°F 19°	6900	1	0.9	658.7	657.7	21.64
2	.31		900	5	4.45	658.4	657.7	-
3	.32		50	10	9.1	658.5	657.7	-
4	11.00	A 45.5 45.2 B	0	10.7	9.8	354.4	354.4	11.64
5.	.45	5.0 5.8	0	10.7	9.8	994.7	993.7	32.41
1	15.10	80°F A 18.2 18.6	7800	1	0.9	660.7	659.7	21.64
2	.12		900	5	4.45	658.7	658.2	21.59
3	.14		0	10	9.1	657.8	657.2	21.30
4	.45	45.6 45.0	0	10	9.1	359.2	359.2	11.64
5	15.48	4.3 4.8	0	10	9.1	963.7	963.7	31.623

For the case of the last solution took the expansion of the liquid.

Meter Experiments —
October 11th Thursday.

By observation following is calibration of upright shaft tubes

Vol: liquid poured in about two filling	Diff	Height of in A	Meniscus in B.	Reading in A	in B.	Mean	cc per cm
30 cc.	30	4·9	5·1	4·9	5·1	5·0	6·0
61	31	10·8	11·2	5·9	6·1	6·0	5·16
88·5	27·5	15·6	16·0	4·8	4·8	4·8	5·73
127·5	39	22·65	23·2	7·05	7·2	7·13	5·47

Mean of last 3 = 5·445

The range between 4·5·3° C and 4·6°C. = 40·7° produced a difference of 5·8 cmc (sum of both legs) = 5·8 × 5·445 = 31·61 cc. in 9 2934 5·3·5 at lower temp = 983 cc. = 3·22% equivalent to about the range in H_2O between 4° + 85° or 81° C.

3·22 ÷ 40·7 = 0·0791 % per·c.

Meter Experiments
Specific Res: + temp. Coefficient of iron wire
October 12th Friday.

Coil No	Length	Drain limited	Drain outward	Res at 14°	Res at 20°	Res at 54°	Coeff: for 14–20°	Coeff per°
I	1398·5	0·0209 0·0247	0·0147 0·0254	22·945	25·090	28·270	4·78	0·797
II	1559	0·0267 0·0160	0·0254 0·0105	26·665	27·960	31·99	4·86	0·81
	Coeff for 20–54°	coeff per 20–54°	Coeff for 14–51°	Coeff per 14–51°	Res at 0 0°C	Area sq. mm	Area / Length	Sp. r.
I	12·67	0·409	19·06	0·488	22·42	65×10⁻⁶	5·62×10⁻⁶ / 1398·5 = 4·02×10⁻³	8·97×10⁻⁶
II	14·41	0·465	19·97	0·540	24·78	5·6×10⁻⁶	5·6×10⁻⁶ / 1559 = 3·59×10⁻³	8·92×10⁻⁶

Motor Experiments contd.

October 12th Friday

The coils of iron (tinned) wire whose coeff. for temp. and p.p. res were observed & recorded on preceding page were obtained from a reel given me by Mr Watt. The measurement were taken electrically by Self and mechanically by Boynton.

Revision of figures relating to the capacity of long tube.

1st measurement	Hennelly + Bugh	921	c.c.
2nd "	Boynton	920	"
3rd "	"	921	"
		Mean 920.7	"

Collected 992 c.c. of the last 80% solution or 44.7% $ZnSO_4$ and as 436.5 of this were supposed to be $ZnSO_4$ added 142 c.c. making 1134 c.c. of assumed 70% or 38.5% $ZnSO_4$ whose density @ 20°C by the bottle is giving at 1.255

The density of this solution after filtration was observed to be 1.320 @ 16.1°C by Hydr. Beam
1.283 @ 16.1 " " balance

The density before the addition of water was 1.355 @ 15.7° by Aquam Hydr.

The distance between the electrodes in the tube after reamalgamating and resetting them was 168.3 cms.

The amount of liquid poured into the tube was 972.5 c.c.

The mean area of the column between the disks taking its volume at 920 c.c. would be

$\frac{168.3}{1728} = \frac{920}{168.3} = 5.467$ sq. cms

The height of the columns at the different temps. were :— at A ~~6.6~~ ~~16.6~~ cms temp. 17. A 9.4
B ~~6.8~~ ~~16.8~~ ~~9.4~~ B 9.5 19.3
A ~~5.6~~ ~~15.6~~ 51.6 A 11.7
B ~~15.7~~ ~~23.4~~ B 11.7 23.4 / 3.5
Rise 14

$\frac{23.4}{3.5} \times 5.45 = 19.3$ c.c. 19.5 in 972.5 = 1.96%
in 34.6° = 0.0567 % per °c. equivalent to water expansion between 4° & 65° : 61°
This result rendered unreliable through subsequent stiffe leakage.
From the 70% series. a = +35.88
b = −1.023
c = +0.01014

$\frac{5.477}{16.3} = 3.254$

The height of the columns were

Temp	A	B	A+B	Diff	%	% per°	
18.5	4.3	5.65	9.95				Thermometer lifted by mistake in tube
48.5 } 43	6.5	7.8	14.3	4.35	2.1448	0.081	
				1.15	0.6646	0.058	
71.5 } 66	3.8	5.0	8.8	5.5	2.698	0.075	Thermometer lifted into shape

8.8 × 5.45 = 47.96 say 48 + 921 = 970 cms.

4.35 × 5.45 = 23.71
1.15 × 5.45 = 6.27
5.5 × 5.45 = 30.0

From this series
a = +35.13
b = −0.92
c = +0.0089

Meter Experiments cont'd :—

No. of Obs.	Time	Solution & temp	Res. in calt.	Mass the battery	Mass the tube	T. Z. calt for load	F.Z. calt for load	Diff.
1	10.25	70% A 16.7 B 16.7	6700	·1	0.9	662.9	662.9	×100
2	·26		800	5	4.5	662.8	662.7	
3	·27		0	10.5	9.6	663.0	662.9	21.5%
4	·46	A 51.6 B 51.6	0	10.5	9.6	332.7	332.7	10.83
5	·50	A 61.6 B 61.2	0	10.5	9.5	912.8	914.5	29.76
6	·51		7000	1	0.9	914.8	914.5	

Collected 1000 c.c. of this 70% solution or 38.5% $ZnSO_4$ and ~~forwarded~~ as it was assumed to contain 385 c.c. of $ZnSO_4.7H_2O$ added 167 c.c. which presumably reduced it to 60% only solution or 33% $ZnSO_4.7H_2O$ which by tables should have a density @ 20°C of 1.313 It was observed to have a density of 1.2413 0.2270 by volume after filtration.

The tube was in those following heat employed without altering the position of the electrodes or remamalgamation of their surfaces.

No. of Obs.	Time	Solution & temp	Res. in calt.	Mass the battery	Mass the tube	T. Z. calt for load	F.Z. calt for load	Diff.
1	14.11	60% A 11.7 B 11.7	7000	7.0	0.9	654.7	654.7	
2	·15		900	5	4.5	653.5	653.3	
3	·16		0	10	9.6	653.0	652.9	
4	·18	A 16.6 B 16.6	0	10	9.6	650.7	650.6	21.1%
5	·43	A 43.7 B 43.3	0	10	9.6	354.7	354.7	11.54
6	15.53	A 60.7 B 60.7	0	10	9.6	889.7	889.3	28.9 d.

$\frac{5.467}{16.3} = 3.249 \times 10^{-2}$

Assuming that $a + bt + ct^2 = \rho$

we have

$$a + 5.2t + 27.0t^2 = 33.01$$
$$a + 19.8t + 392.04t^2 = 21.62$$
$$a + 48.8t + 2381.44t^2 = 12.88$$

whence

$$a = +38.11$$
$$b = -1.035$$
$$c = +0.0102$$

Meter Experiments cont.

October 14th Saturday)

Recovered 1000 c.c. of the last 60% solution & observed it to have a density of 1.280 @ 17.6°C by Hydrometer. As it was assumed to contain 330 c.c. of $ZnSO_4$ added 200 c.c. making 1200 c.c. of dilution assumed to have 27.5% of $ZnSO_4 + 7H_2O$ which by tables has a density of 1.172 @ 20°C.

The observed density was 1.203 @ 21.0 by balance
1.245 @ 19.1°C - Reammi Hyd

The distances between the disks after remagnetization was observed to be 167.4 cms.

The observed contents of the tube up to the base of the shaft was 918 cc. this displaced 167.4 = 5.484

No. of obs.	Time	Solution & temp.	Res. in 10^{-6} ohms 20°C	Max. Res. in the tube	Max. Res. tube	T.Z. off for tube	FZ off for tube	cf. r.
1.	10.15	60% S 19.7 B 19.7	7000	1	0.9	660.9	660.9	
2	.16		900	5	4.5	661.0	660.7	
3	.17		0	10	9.7	660.3	660.6	21.62
4	.50	A 26.6 B 19.0	0	10	9.1	393.6	393.6	12.88
5	11.42	A 5.0 B 5.0	0	70	39.5	100 ~~f~~ 2	100 ~~f~~ 2	33.01

Expansion of liquid.

No. of obs.	Time	Mean temp	Height in A	Height in B	Sum A+B	Diff	Diff temp	Diff for 1°C change	Diff for 1°C change
1	11.42	5.1	7.4	7.5	14.9				
2	10.15	19.8	8.15	8.10	16.25	1.35	14.7	0.736	0.050
3	10.50	48.8	10.35	10.35	20.7	3.45	29.0	2.420	0.084
						5.80	43.7	3.162	0.073

1.35 × 5.48 = 7.36 ÷ 918 + 5.48 × 18 = 52 = 1000
4.45 × 5.48 = 24.4 ÷ 918
5.80 × 5.48 = 31.8 ÷ 918

Experiment cont. –

Oct. 12th Saturday

Temp. of meter bottle under heat –

		Hot	Meter		Cool meter
Oct. 12th	17.45				
		Shunt 60·5	62·2	Bulb 25	27·2
13th	15·00	60·5	62·2		30·0

Wt. of transformer armature after the two coils (new) connected up in gramme ring fashion and soldered.

Insulation between two coil about 8000 = 4 8500 =

Res. of fine wire coil 43·50 but 0·480 = 43·980

= 172·8 ω in all

– coarse – 1·226 – 0·43 = 0·796 ω

= 3·984 ω in all

Dividing these by 36 we have as the future total res. of the machine excluding self induction + connecting wires

coarse wire circuit 4·80 ω

fine wire coil 0·083 ω

Phonograph Batteries.

October 17th Saturday.

German Chromic acid having been substituted for American chromic acid in the phonograph cells, & complaints about their energy having since been made the following tests were made to investigate the cause of failure.

The solutions made up were :-

No. Acid		Un. Formula	Actual Quantities used	Weight of the plate	Initial EMF	Current after 1 hour	Length of time shown in curve
1	Gr. Chromic Acid Solution & Water	5 10 25	8 g. 270 c.c. 1135 c.c.	415	2·012	2·688	5 hours
2	Gr. Chr. Ac. H_2SO_4 H_2O	5 15 25	7·2 g 336 c.c. 1021 c.c.	392	2·028	1·544	0·8
3	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 10 25	11·3 g 234 c.c. 1066 c.c.	407	2·006	3·040	7·50
4	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 15 25	10·1 g 314 c.c. 953 c.c.	377	2·076	1·736	3·4
5	Gr. Chr. Ac. H_2SO_4 H_2O	10 18 25	14·1 g 219 c.c. 997 c.c.	404	2·056	3·104	9·0
6	Gr. Chr. Ac. H_2SO_4 H_2O	10 15 25	12·8 g 299 c.c. 907 c.c.	412	2·104	2·464	8·0
7	Gr. Chr. Ac. H_2SO_4 H_2O	7·5 15 20	9·7 g 299 c.c. 799 c.c.	405	2·040.	2·552	5·5

The cells were started each in 0·5 platinoid element at 8·15 and the accompanying curve is the plot of the observations.

Meter Experiment cont:-

October 16th Sunday:-
Took down hot and cool meter, dried and weighed plates:-

Met. No	Weight 4.10.95		Joint Weight + Cover	Weight 10.15	Joint Wt Weight Prism.	Gain	Loss.	M
1	87.88	39	174.3983	87.3964	175.4558 / 174.4356	0.5513		
2	87.55	24	174.3975 +0.0008	87.0392	0.0000 +0.0181		0.5132	
3	90.05	82	178.0907	90.6044	178.1323	0.5762		
4	88.03	12	178.0994 + 0.0013	87.5286	178.1320 −0.0007 +0.0436		0.5026	
5	91.70	28	182.0906	92.2256	182.1173	0.5228		
6	90.38	75	182.0906 0.0000	89.8927	182.1183 +0.0010 +0.0277		0.4951	
7	87.88	69	175.8552	88.3368	175.9466	0.4499		
8	87.96	93	175.8562 −0.0010	87.6107	175.9475 −0.0007 +0.0913		0.3586	

As there was some glaring discrepancy in these results, Mr Wirt tested the hot meter on Oct. 16th Monday & found the res. of

The left hand dials of pol. & shunt before endowing of the screws 8.51 after 8.17
" right " " " " " " " " 9.36 " 8.24

Thus showing that bad contact had been made at these screws, and that consequently all the results hitherto collected on these two meters are unreliable

$0.174 \times 8.5 = 1.5$ grs per cm
3000 cm $= 4500$ grs $= 9.0$ lbs roughly.

Calculation for the dimensions of a platinoid strip that shall serve in a standard meter and which shall consequently not rise in temp. on 10°C when carrying a current of 20 amperes.

If the strip have a width of w
a thickness of t
a spec. res. of ρ
a traversing current c

Then the res. of the strip will be per linear cm

$$\frac{\rho}{tw}$$

and the energy expended in traversing it per cm

$$\frac{c^2\rho}{tw}$$

the heat units (therms) generated per sec.

$$\frac{c^2\rho}{4.2tw \times 10^7}$$

The surface of the strip $= 2w$ per neglecting the edges and the radiation in therms per sec.

$$= \frac{2\theta w \times 2 \times 10^{-4}}{}$$

$$\therefore c^2\rho = 16.8\, tw^2\theta \times 10^3$$

$$\therefore tw^2 = \frac{c^2\rho \times 10^{-3}}{16.8\,\theta}$$

Here $c = 2$ $\rho = 4.03 \times 10^{-6}$ $\theta = 10$

$$\therefore tw^2 = \frac{16.12 \times 10}{16.8 \times 10} = 0.96$$

If we make w the present width i.e. 5.5 cm

$$t = \frac{0.96}{30.25} = \frac{9.6 \times 10^{-1}}{3.025 \times 10^1} = 3.17 \times 10^{-2} = 0.0317$$
$$= 0.125''$$

If made 5.5 cm wide the sectional area would be
$3.17 \times 10^{-2} \times 5.5$ or $17.44 \times 10^{-2} = 1.744 \times 10^{-1}$ sq. cm per cm.
$= \frac{4.03 \times 10^{-6}}{1.744 \times 10^{-1}} = 2.316 \times 10^{-5}$ ohs per cm $= 2.316 \times 10^{-4}$ ohs for 0.1 m we require
$\frac{4.03 \times 10^{-6}}{3.1415 \times 10^{-1}} = 0.0128 \times 10^{-5} = 1.28 \times 10^{-4}$ $= 4.32 \times 10^{-4} = 0.43$ ohs.

$\frac{908}{167.5} = 5.420$

$\frac{5477}{167.5} = 327$

Meter Experiments cont'd :—

October 16th Monday.

Collected 1000 c.c. of the last or 50% solution assumed 27.5% $ZnSO_4 + 7H_2O$, and observed its sp. g. to be 1.245 by Beaumé Hydr. @ 19.0° C., and added 250 c.c. of H_2O dist. to obtain 40% sol: or 22% $ZnSO_4 + 7H_2O$. The sp. gr. of this solution is by table 1.136 @ 20°.0. After filtration the diluted solution was 1.1659 @ 22°.0 by balance 1.205 @ 18.1°. Hyd. B.

Took the following tests.

Dist: between amalgamated electrodes 167.5 c.

Capacity of tube 908 c.c.

No.	Time	Solution strength	Resist.	Mins. for testing	Mins. flow tube	Volt for F.Z.	Volt +3 F.Z.	Sp.
1	14.05	40% A 19.1 B 14.4	7000	1	0.9	753.7	753.3	24.4
2	.07		800	5	4.5	746.0	745.7	24.2
3	.08	T.B. 24.6	0	10	9.1	744.0	744.0	24.33
4	.36	A 50.6 B 51.3	0	10	9.1	433.3	433.2	14.16
5	15.40	A 0.7 B 5.6	7010	4	0.5	1143.7	1133.7	36.7
			0	12	6.0	1074.7	1074.7	35.15

Expansion observations

No.	Time	Mean Temp.	Height A	Height B	Sum	Diff. Diff.	Diff. Diff. Temp.	% Change	Temp. per 10
1	15.40	4.9	7.0	7.7	14.7				
2	14.05	19.2	7.6	8.3	15.9				
3	14.36	51.2	10.0	10.7	21.7				

Multipolar Dynamo Experiment.
October 16th Monday

Ran New octopolar Dynamo with :—
The eight magnet coils on each side in series and the two sets then in parallel on the 110 volts circuit

The current in the fields was then 12 ampere 6 on each side and the voltage at the terminals 91 speed being a little under 800 rev. per min.
Ran at this rate and under this field, but without supplying current from 11.10 to 13.0
The temp. shewn by a thermometer laid on the armature periphery and covered by waste was 140°F.

To increase the voltage connected the magnets in four sets of four each.

The current being then 40 ampere obtained 130v
= 10 ampere per coil
and at 31 ampere obtained 112
7.75 " per coil
the speed steady at 792.
On exciting the field from the #8 machine at full potential with the magnets in two rows of eight, reached 130 volts at 18 ampere or 9 per coil.
The highest armature temperature reached was after two hours run 17.0 = 165°F

Calculation for the length and carrying capacity of a line of iron rods.

The length of each rod is about 10·6" or 320 cms
- diam. - - - - 0·5" or 1·27 cm.
- area - - - - - 0·1964 □" = 1·267 □cm
- measured res. - - - - 3·0 × 10⁻⁵ at 20°C.
- sp. res. then being $\frac{3.0 \times 10^{-5} \times 1.27}{320 \times 10^{2}} = 1.19 \times 10^{-10}$

The heat units generated by a current of strength c per linear cm. will be $\frac{c^2 \times 1.19 \times 10^{-10}}{1.27}$ per sec. $= \frac{c^2 \times 9.37 \times 10^{-8}}{4.2 \times 10^{7}} = 2.23\, c^2 \times 10^{-16}$

The thermal radiated

$$= 1.27 \times 3.14 \times \theta \times 2.8 \times 10^{-5}$$
$$= 7.97\, \theta \times 10^{-4}$$

$$\therefore \theta = \frac{2.23\, c^2 \times 10^{-16}}{7.97 \times 10^{-4}} = \frac{22.3\, c^2 \times 10^{-16}}{7.97} = 2.80\, c^2 \times 10^{-13} = 0.280$$

for 1000 ampere $c^2 = 10000 \quad 10 \times 10^{6}$

$$\theta = 3 \times 10^{-3}$$

for 800 - $c^2 = 64000 \quad \theta = 179.0°$ C.

- 500 - $c^2 = 2500 \quad \theta = 700°$ C.

180 feet of rod with having initially a temp. of 20° would have res. of $1.80 \times 10^{2} \times 3.05 \times 10^{-5} \times 9.37 \times 10^{-8} = 5.1444 \times 10^{-2}$ ω neglecting the res. of joints, so that the current initially would be merely

$$\frac{120}{0.051} = 2400 \text{ amperes.}$$

at 700° C. the res. will have risen at least 300% (300×0.5) making the res. 0.20 and limiting the current to 600 amperes.

Meter Experiments. cont.

October 12th Friday

Measurement by Mr Wirt of the mag. of the 25th meter bottle in series set up Oct. 5th

No.	Time.	Time elapsed since starting over cell for lads, reduced to hours	Reg. Measured cell for lads, reduced to amps	Bridge no.	Temp.
1	10·10	0	9·0	1000/100 1 mag.	22·0
2	·30	20	7·8	Lead 0·24	
3	11·00	50	6·5		
4	11·15	1·05	5·9		
5	11·35	1·25	5·4		
6	11·45	1·35	5·1		
7	13·35	3·25	4·2		24·0
8	13·45	3·35	4·1		21·80
9	14·00	3·50	4·1		
10	14·15	4·05	3·9		
11	14·55	4·45	3·9		
12	15·15	5·05	4·0		24·
13	15·35	5·25	4·0		

$\frac{5477}{167.4} = .13272$

Assuming that we have

$$a + bt + ct^2 = f$$
$$a + 14.9t + 24.01t^2 = 35.82$$
$$a + 19.3t + 372.5t^2 = 24.34$$
$$a + 51.2t + 2621.4t^2 = 14.18$$

Whence

a	$= +40.76$	1.047
b	$= -1.052$	1.076
c	$= +0.01014$	1.134

Meter Experiments contd :— (29)

October 18th Monday.

Collected 1000 c.c. of the last or 50% solution. (27% alt.) of density 1.2148 @ 19°.0 C. and added 2501 c.c. H_2O dist. to obtain 1250 c.c. of 40% solution (22% salt.) which by table has a density of 1.1355, and was observed to be 1.1659 @ 22.0 C by balance or 1.205 @ 18.1°.0 C hydrometer.

Distance of electrodes apart 167.4 cms

No of Obs.	Time	Solution Temp	Resistance est.	Mins the battery	Mins the tube	Bridge set	T.Z. calc. for tube 02	F.Z. tube 02	f.r.
1	14.00	19.1 A 19.1 B 19.0	7000	1	0.9	1000 from	702.7	753.3	
2	.02		800	5	4.5	58.2	746.2	745.7	
3	.03		0	10	9.1		746.0	746.0	24.34
4	.05								
5	.36	19.95 B 21.8	0	10	9.1		433.3	433.2	14.18
6	15.40	19.7 B 6.3	7000	10	9.0	1000 from	1133.7	1133.7	
7			0	12	6.0		1095.7	1094.7	35.82

No of Obs.	Time	Height of mercury A	B	Sum	Mean temp	Diff. bulb	Diff. bulb. stem	Diff. bulb.	
1	14.0	7.6	9.3	14.9	19.3	14.4	2.2		
2	14.40	10.0	10.7	20.7	5.62	{34.9 / 46.3}	{3.8 / 6.0}		
3	15.40	7.0	7.7	14.7	4.9		0.0		

Octofular: Dynamo Tests.

October 16th Tuesday.

Commenced running at 12.55

Charged field May 2 sets of 8 from 107 volts P.D. 92 volts

" " 175 " " " " 181 " " 123 "

Revs. 783

Noon shut down for lunch air 80°F

after 1st 5' 110°

10' 128°

12.10 Commenced running P.D. 119. 16.5 amp. Field

.55 stopped air 79°F

5' 172

10' 183.

13.05 Started. 16 ampère 119 volts

.55 stopped air 81°F

5' 173°

10' 190°

14.05 Started 16 ampère 119 volt

.55 stopped air 80°F

5' 170

10' 182

15.05 Started 16 ampère 118 volts

.55 Stopped air 76°

5' 164°

10' 178°

16.05 Started 16 ampère 123 volts speed 800 revs.

.55 Stopped air 80°

5' 179°

10' 192° (Thermometer touching bend)

17.05 Started 16 ampère 123 volts

18.00 Stopped air 80°

5' 124°

10' 150°

18.10 Started 16 ampère 123 volts

19.00 Stopped air 70°. 5' 156° 10' 176°

.10 Started 16 ampère 124 volts

21.10 Stopped air. 70° 25' 182°

5' 167° 30'. 182°

10' 180°

15' 182°

20' 184°

(Phonograph Battery) Tests
(October 16th Tues day)

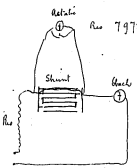
3 cells of 2 quart size were made up with 8% Zinc plates and the usual formula 7.5 parts Am. chromic acid 15 parts H_2SO_4 comm. + 40 H_2O. They were worked through the day upon 0.5 ω and are in every respect comparable with those based on the 18th with Germain Chromic acid. The curves are shewn on the opposite page. Whereas the longest lifetime above 2 ampères was 9 hours with the Ger. Chr. acid it was now than 13 with the American.

Heat data.

Mr Wirt supplied following information concerning the heating of wire

60 Watt per sq in (i.e. 9.263 Watt per sq cm) produces full red heat in

10 - - - - (i.e. 1.55 Watt per sq cm) melts him.



			microhms
Res. of	1 strip shunt	0.00138 ± 6.00000043	1380 ± 43
"	" Check "	0.000197 ± 0.000000006	197 ± 6
"	2 " in parallel	0.000098 ± 0.000003	985 ± 3
"	3 " "	0.000065	657
"	4 " "	0.000049	49.3
"	5 " "	0.000039	39.4
"	6 " "	0.000032	32.8
"	7 " "	0.000028	28.1
"	8 " "	0.000024	24.7

Tests and Calculations of the 1000 Ampere Shunt.

52

Each connection is made up of 23⅝" length of platinoid strip ⅛" thick and 2¼" wide.
Or in cms. 60 long × 60·96 × 0·159 thick
The area is thus 60·96 × 0·159 = 9·692 sq. cms
and the res: of the whole connection is thus assumed to be $\frac{4.032 \times 10^{-6} \times 60}{9.692} = 2.496 \times 10^{-6}$
$= 25 \times 10^{-5}$ ω. ∴ 250 microhms × 7·9 = 1·975 microhms = 0·00175 in ω
The P.D. on the machine terminal on the passage of an current of c ampere = $2.5 \times 10^{-6} \times C$ volt
where n is the number of plates in parallel
40 amperes traversing one plate would therefore produce ½ of a volt. or if all the plate were in series it would give 0·07 volt

Joined up the shunt with the Check Galvo and platinoid resistance board. Results as follows:-

No. of Obs	Check Defl.	Current to Main	Defl. on Galvo	Constant of Galvo	Value of one div. in ohms	Corresponding current in Galvo	P.D. on shunt ohm value	Res. of shunt ohm value	Calculated value
1	+1·02	0.5·06	+31·0	1 ohm at 1 div.	0.45×10^{-3} / 2·165	9.96×10^{-3}	1.37×10^{-6}	1.46×10^{-6}	1.75×10^{-6}
2	+1·02	0.5·06	−32·0	@ 71·1° Mod. 20000		230·0	7.61×10^{-6}	1.50×10^{-6}	
3	+1·74	0.9.67	55·5	+Galvo = 2·16	3.15×10^{-3}	$17.00 \times$	13.2×10^{-6}	1.37×10^{-6}	
4	+1·72	0.9.61	53.	+2·17		$17.00 \times$	12.6×10^{-6}	1.31×10^{-6}	
5	+0·33	1·93	10·0	20·7 = 23·5C		$\frac{232}{1.37}$ =		2.38×10^{-6}	1.30×10^{-6}
6	−0.33	1·93	10·25	+ 1·27 = 1.237 × 20·5 =		$\frac{232}{1.37}$ =	2.40×10^{-6}	1.33×10^{-6}	
							Sum	2.37 / 1.38	

No. of Obs	Res. of Shunt deduced	Mean	v	v²	Σv²	Σv²/(n(n−1))	Value probable mean
1	1.46×10^{-6}	1.38	0.08	0.0064	0.03247	0.00027	1.38 ± 0.016
2	1.50		0.12	0.01424			
3	1.37		0.01	0.0004			
4	1.31		0.07	0.00449			
5	1.30		0.08	0.0064			
6	1.33		0.05	0.0025			

$\frac{5.477}{167.3} = 3.274$

Assuming that we have

$a + bt + ct^2 = \rho$

$a + 6t + 36c = 39.5$

$a + 16.6b + 275.6c = 29.6$

$a + 51.5b + 2652.3c = 16.2$

whence

$a = +46.3$ 1.10

$b = -1.207$ 1.23

$c = +0.0125$ 1.32

$5.45 \times 2.1 = 114.5$

$\underline{952.5}$

$1022.$ @ 6.0°C. } 45.5°C.

and 35.424 @ 51.5°C

$= 3.395$ for 45.5°C

$\cdot 0426$ " $\therefore$ 90.

Meter Test contd.

October 16th Tuesday.

Collected 1000 c.c. of the last or 40% sol. (22% wt.) of observed density 1.167 @ 14.6°C and added 333 cc. of H_2O dist. to produce 1333 c.c. of 30% solution (16.5% wt.) which by bottle has a density at 20°C of 1.100, and was observed to have a density of 1.128 by balance @ 19°C.

or 1.127 " Hydr. @ 15.3°C.

Electricity 167.3 cms after

No.	Time	Temp. solution	Bridge	Res. in cot	Mean Res. battery	Mean to tube	TX cold	FX hinds 0.3	sp. r.
1	9.47	24° & 16° 8.68	100/100	7000	1	0.91	914.7	913.7	29.91
2	.50		78.17	600	5	4.5	907.7	906.7	29.69
3	.52			0	8	7.3	906.3	905.2	29.64
4	10.35	50.24 8.51.6		0	10	9.1	493.2	492.2	16.15
5	11.27	8.60 8.60	100/100	0	8	6.0	1209.7	1208.7	39.51

No.	Time	Temp of A	Temp of B	Mean	Diff. temp t	Diff. heat Sensible	Diff. heat Latent	Diff. vol.
1	9.50	10.8	11.6	22.4	16.6°C	10.6	1.4	
2	10.35	15.4	14.1	27.5	51.5°	{314.9 / 45.5}	{5.1 / 6.5}	
3	11.27	10.3	10.7	21.0	6.0			

Assuming that $\rho = a + bt + ct^2$

we have
$$a + 6.1b + 37.22c = 50.6$$
$$a + 22.96b + 522.4c = 33.5$$
$$a + 53.46b + 2851.6c = 20.6$$

whence
$$a = +58.56 \qquad 1.3315$$
$$b = -1.383 \qquad 1.2413$$
$$c = +0.0126 \qquad 1.3316$$

Meter Tests contd —

(54)

Wednesday October 17th

Collected of the last of 30% solution (16.5% salt) 1000 c.c. of density 1.127 @ 19.6°C. and added 500 c.c. of distilled water to reduce it to 20% solution (11.0% salt) whose density by bottle is 1.065 @ 20°C and observed to be 1.056 @ 20.7°C by hydr
1.054 @ 21.2°C " balance

Electrodes 167.5 cms apart

No. of obs.	Time	Sol. temp.	Bridge	Res. in ohms	Mean Res. fall	Mean Res. bottle	T.Z. corrected	F.Z. corrected	sp. r.
1	10.34	20.4 & 22.0 / 22.4	100/100 / 70/220	6400	·1	0.5	1018.7	1012.7	34.13
2	·35			500	5	4.5	1030.7	1028.7	33.63
3	·36			0	·7	3.5	1027.7	1025.7	33.54
4	·38	20.53.6 / 6.53.2	100/100	0	10	9.8	630.7	620.7	20.62
5	11.57	A 5.9 / B 6.2	100/100	0	7	3.5	1539.7	1536.7	50.55

No. of obs.	Time	Height of meniscus A	B	Sum	Mean temp.	Diff temp.	Diff. temp. from mean	Diff. sp. gr.	
1	10.35	11.85	11.3	23.15	22.8	16.7	1.45		
2	10.58	13.8	13.8	27.6	53.4	{30.6 / 47.3}	{3.45 / 5.9}		
3	11.57	16.8	10.9	21.7	6.1				

Water Tests. Zenith –
October 17th Wednesday.

Collected 1000 c.c. of the last or 20% sol. (11% salt) in copper and added 1000 c.c. of H_2O dist: to reduce it to 10% sol (5.5% salt) whose tabular density is 1.032 the desired density being 1.043 by Hydr @ 19.9°C
1.043 – balance @ 20.5°C

Electrode 167.5 apart

No.	Time	Sol. temp	Bridge	Thermo-ed	Min. the bottle	Min. the tube	T.I. cells	F.I. cells	cf.	
1	14.15	10% 18.8 20.1	100 from 26.6°	7408	1	0.5	1780.7	1772.7	57.99	
2	·17			100	100	2.5	1758.7	1754.7	57.35	
3	·19			0	5	2.5	1757.7	1754.7	57.33	
4	·42	S 20 6 20.6		0	5	2.5	1027.7	1024.7	34.26	
5	15.18	S 5.0 6 10.1		0	5	2.5	2018.7	2014.7	65.88	

No.	Time	Height of Manometer A	B	Sum	Mean Temp	Diff Temp	Diff bad sum	Diff vol.	
1	14.15	10.6	10.2	20.8	19.6	4.55	0.70		
2	14.42	12.95	12.55	25.50	51.9	[22.3 26.22]	[4.70 5.50]		
3	15.18	10.4	10.1	20.5	15.05				

Calculations for the carrying capacity of 30 # 9 wire B.W.G galvanized iron d. 1.48" = 0.376 cm. diam + 800 feet = 24400 cm long.

800 ampere ÷ 30 = 26.7 amperes per wire.

1 wire of galvanized iron wire offers $\frac{360\,000 \times 800}{(1.48)^2 \times 5280}$ at 60°F

$= \frac{3.6 \times 10^5 \times 8.0 \times 10^3}{2.19 \times 10^4 \times 5.28 \times 10^3} = \frac{28.8 \times 10^7}{11.56 \times 10^7} = 2.49\,\Omega$ say 2.5

By Geneva tables $\frac{16.4 \times 800}{5280} = \frac{13.12}{5.28} = 2.53$

at 100 volt therefore each wire will take initially 40

The limiting temp of the wire under these conditions will be

$$\theta = \frac{4\,C^2\rho(1+0.0058)}{J\pi^2 d^3 k} \qquad \theta\,(J\pi^2 d^3 k - 0.20\,C^2\rho) = 40^2\rho$$

$$\theta = \frac{40^2\rho}{J\pi^2 d^3 k - 0.20\,C^2\rho}$$

Here $\rho = \frac{16.4 \times 10^7 \times 0.11124}{16\,093} = \frac{1.64 \times 1.110}{1.609} \times 10^{14} = 1.13 \times 10^{14}$

C = say 4

$k = 3 \times 10^{-4}$

$J = 4.2 \times 10^7$

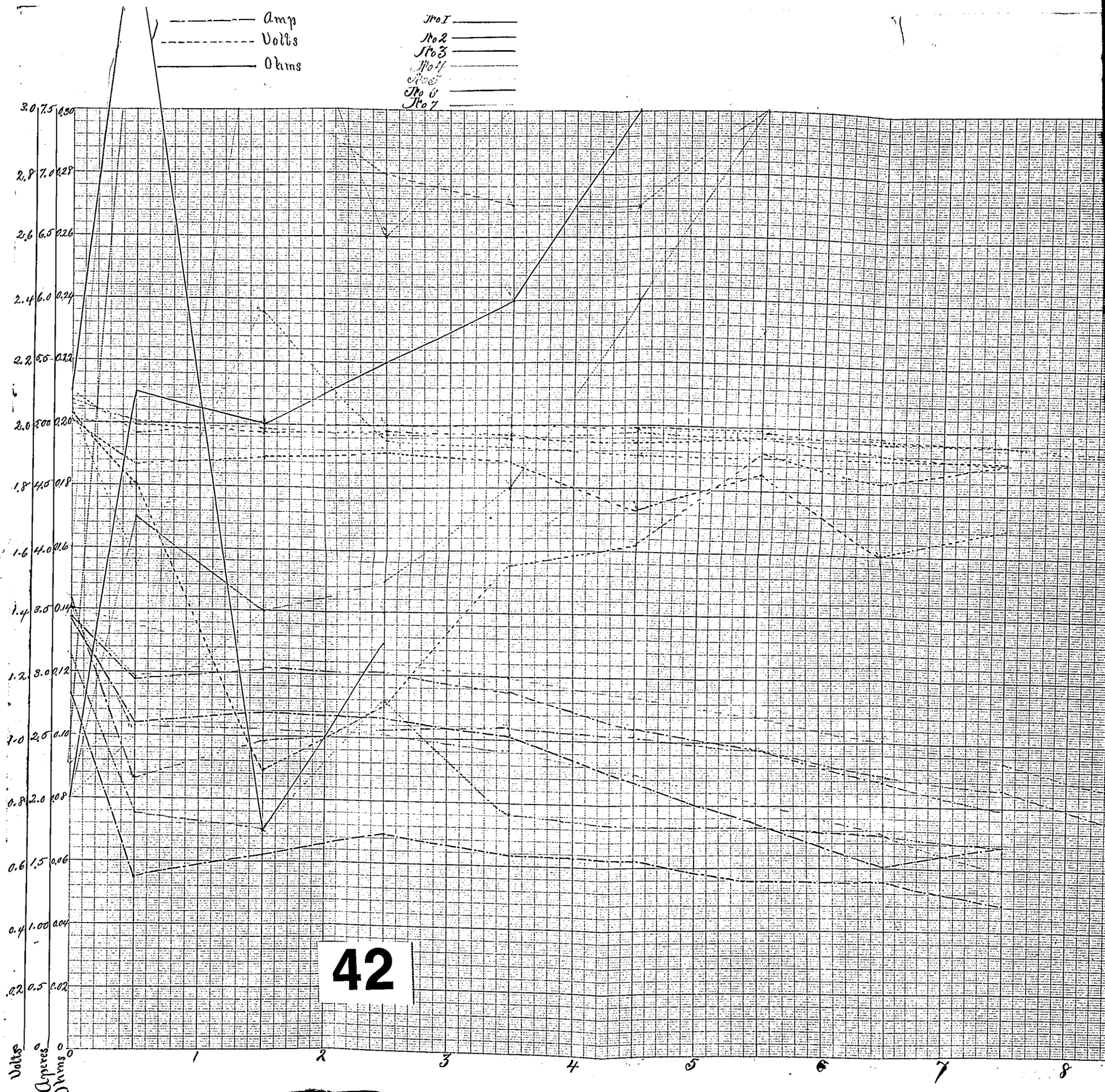
$d = 3.76 \times 10^{-1}$

$$\theta = \frac{4 \times 16 \times 1.13 \times 10^{14}}{4.2 \times 10^7 \times (3.76)^3 \times 10^{-3} \times 9.87 \times 3.0 \times 10^{-4} - 2.0 \times 1.6 \times 1.13 \times 10^{14}}$$

$$= \frac{7.23 \times 10^5}{4.2 \times 5.316 \times 9.87 \times 3.0 \times 10 - 2.0 \times 1.6 \times 1.13 \times 10^{14}}$$

$$= \frac{7.23 \times 10^5}{6.61 \times 10^7 - 3.62 \times 10^3} = 2.40°\,C \text{ rise at most}$$

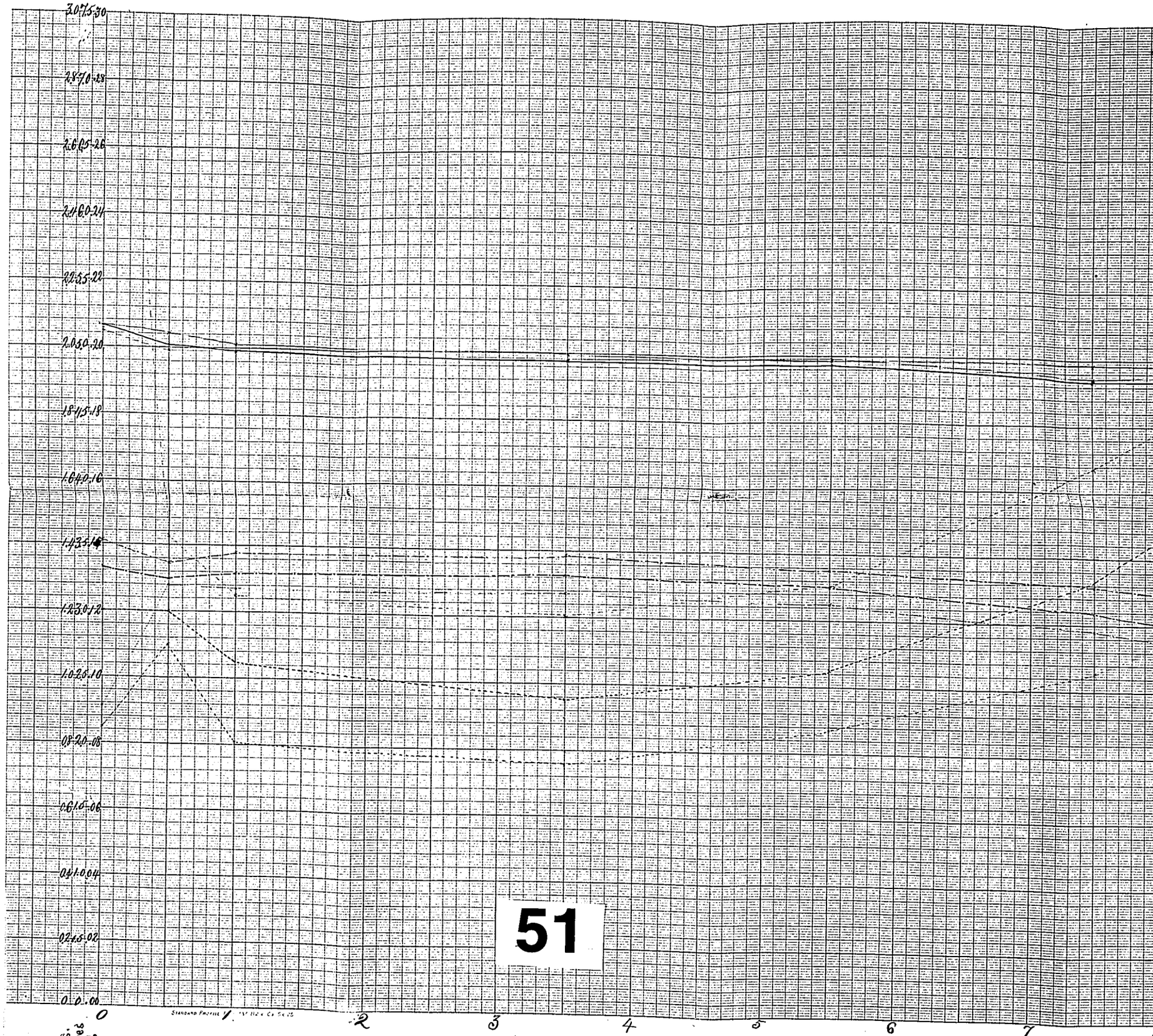
at which temp: it would have a sp. res. of $2.2 \times 1.13 \times 10^{14}$ ohms and the res: of 800 feet would be $\frac{2.486 \times 10^{14} \times 2.45 \times 10^{4}}{3.11 \times 10^{-1}}$ $= 5.1465\,\Omega$ and the limiting current 20 ampere.


Amp
Volts
Ohms
No 1
No 2
No 3
No 4
No 5
No 6
No 7
Volts
Amperes
Ohms
3.0 7.5 0.30
2.8 7.0 0.28
2.6 6.5 0.26
2.4 6.0 0.24
2.2 5.5 0.22
2.0 5.00 0.20
1.8 4.5 0.18
1.6 4.0 0.16
1.4 3.5 0.14
1.2 3.0 0.12
1.0 2.5 0.10
0.8 2.0 0.08
0.6 1.5 0.06
0.4 1.00 0.04
0.2 0.5 0.02
0 0 0
0 1 2 3 4 5 6 7 8
42

No 1
No 2
No 3

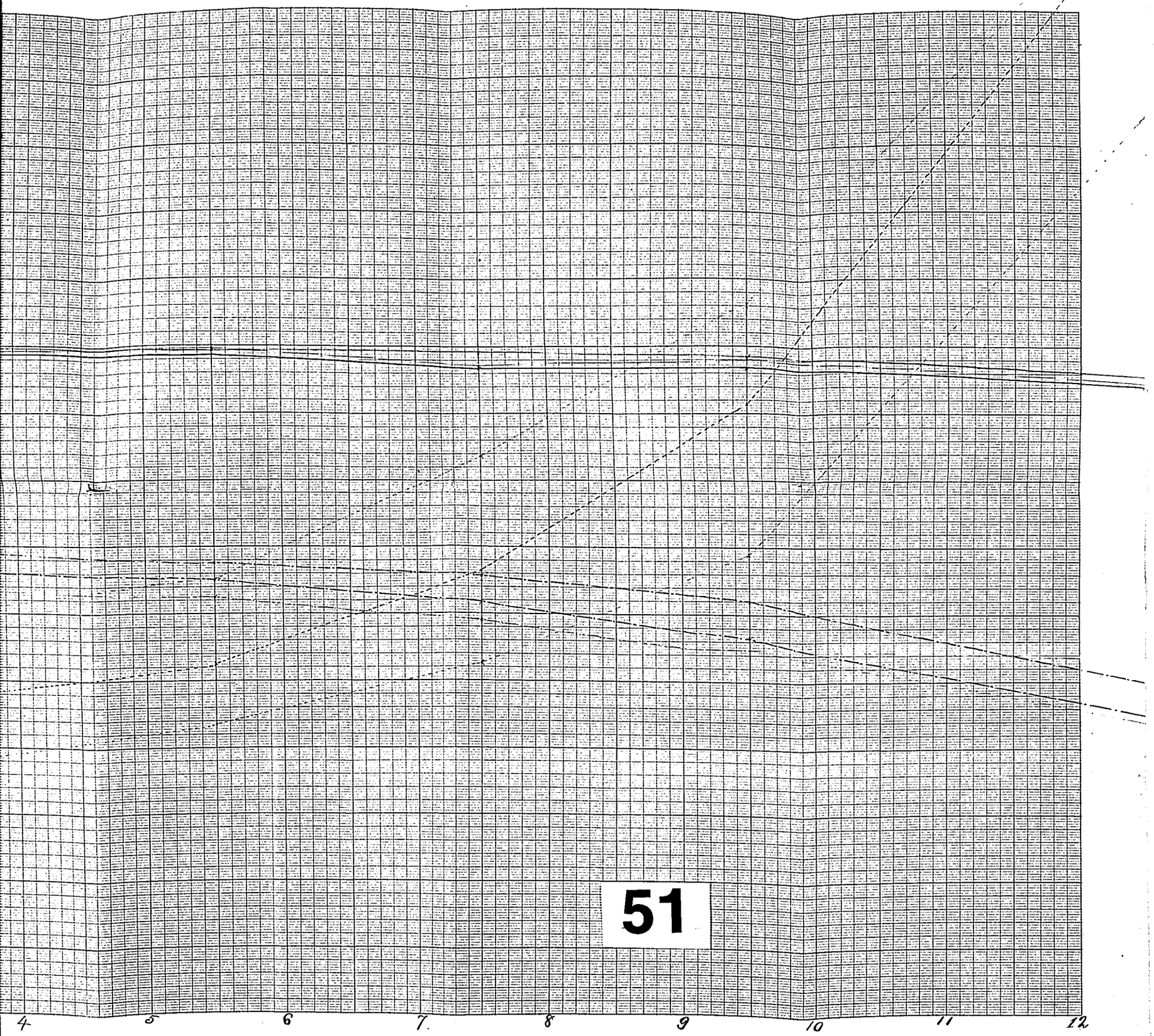
Amperes
Ln. Resist.
Volts.

Oct. 17. 1888



Volts.
Amperes
Ohms

Oct. 17. 1888



Notebook, N-89-03-01

This notebook covers the period March 1889-February 1891. It was used by an unidentified experimenter in the test room for notes on tests of experimental lamps and squirted filaments. Included are notes on "Edisons new process of making squirted carbons" and "Edison's experiments on clamps." The pages are unnumbered. Approximately 90 pages have been used.

Edisons new process of making squirted carbons Mar-1-1889

Edison Order No 1 Mar-1-1889
Lamps made 18
Carbons reel 44

Edison Order No 2 Mar-1-1889
Lamps made
Carbons reel 23

Edison order No 3 Mar-4-1889
Lamps made 14
Carbons reel 23

Edison order No 4 Mar-4-1889
Lamps made 18
Carbons reel 29

Edison order No 5 Mar-4-1889
Lamps made 18
Carbons reel 31

Edison order No 6 Mar - 4 - 1889
Lamps made 14
Carbons recd 22

Edison order No 7 Mar - 4 - 1889
Lamps made 12
Carbons recd 18

Edison order No 8 Mar - 7 - 1889
Lamps made 15
Carbons recd 18

Edison order No 9 Mar - 7 - 1889
Lamps made 7
Carbons recd 14 short

Edison order No 10 Mar - 7 - 1889
Lamps made 12
Carbons recd 14 short

Edison order No 11 Mar - 7 - 1889
Lamps made 15
Carbons recd 20

Edison order No 12 Mar - 8 - 1889
Lamps made 10
Carbons recd 18 short

Edison order No 13 Mar - 8 - 1889
Lamps made 10
Carbons recd 24 spotted

Edison order No 14 Mar - 9 - 1889
Lamps made 11
Carbons recd 19

Edison order No 15 Mar - 9 - 1889
Lamps made 12
Carbons recd 28

Edison order No 16 Mar - 9 - '89
Lamps made 11
Carbons reel

Edison order No 16 Mar - 21 - '89
Lamps made up in series

Edison order No 17. Mar 11 - '89
Carbons reel 9. N. G. Little Falls no
carbons, not made up.

Edison order No 18 Mar - 11 - '89
Carbons reel 20. These carbons were
same as No 17, and were not made up)

Edison order No 19 Mar 11 / 89
Carbons reel 25. short, not made up

Edison order No 20 Mar - 11 - 89
Lamps made 13
carbons reel 19

Edison order No 20. Mar 21 - 89
Lamps made up in series 2.

Edison order No 21 Mar - 16 - 89
Lamps made 11
Carbons reel 21 recarbonized

Edison order No 21 Mar 13 - '89
Carbons reel 21, Reg. not made up
carbons split lengthwise

Edison order 22. Mar - 13 / 89
Carbons reel 11 not made up

Edison order No 23 Mar - 16 - '89
Lamps made 9
carbons reel 14 recarbonized

Edison order No 23. Mar - 13 / 89
Reg. not made up.
Carbons reel 29, split in shank
lengthways

Edison order No 24 Mar-18-89
~~Lamps~~ rec'd 18. N.G. little balls on carbons not made up

Edison order No 25 Mar-18/89
Carbons rec'd 18 not made up, was same as No 24

Edison order No 26 Mar-18-/89
Carbons rec'd 11 N.G. got little balls on carbons. not made up

Edison order No 27 Mar-18/89
Carbons rec'd 9 N.G. not made up, short, and same as No 26

Edison order No 28. Mar 18-/89
Carbons rec'd 16. N.G. not made up little balls on carbons

Edison order No 29. Mar 18-/89
Carbons rec'd 19.
Not made up.

Edison order No 30 Mar 18/89
Carbons rec'd 14 N.G. not made up little balls on carbons

Edison order No 31 Mar-18-89
Carbons rec'd 15. N.G. not made up little balls on carbons

Edison order No 31 Mar-19-89
Carbons rec'd 14. not made up

Edison order No 32. Mar 19-89
Carbons rec'd 9. not made up

Edison order No 33. Mar 19-89
Lamps made 4
Carbons rec'd 8

Edison order No 34 Mar. 22-89
Carbons rec'd 7. not made up

Edison order No 35 Mar 22, 89
carbons rec'd 6. 2 good one full
length not made up

Edison order No 36 Mar 22, 89
Lamps made 5
carbons rec'd 15. short

Edison order No 37 Mar-22-89
carbons rec'd 9. not made up

Edison order No 38 Mar 22, 89
Lamps made 4
Carbons rec'd 8 short

Edison order No 20 a Mar 29, 89
Lamps made 8
Carbons rec'd 10

Edison new No 1 Apr-12-89
carbons all broken short

Edison new No 2 Apr-22-89
Lamps made 1
carbons rec'd 12. short

Edison new No 3 Apr-12-89
Lamps made 3
Bal of carbons broken

Edison new No 4 Apr-12-89
Lamps made 12
carbons rec'd 09

Edison new No 5 Apr 12-89
Lamps made 10
Carbons rec'd 25

Edison new No 6 Apr 12-89
Lamps made 4
carbons rec'd 12. Broken

Edison new No 7 Apr. 12-89
Lamps made 18-
Carbons mld 54

Edison new No 8 Apr. 12-89
Lamps made 18-
Carbons mld 40

Edison new No 9

Edison new No 10

Edison new No 11

Edison new No 12 Apr. 12-89
Lamps made 18-
carbons mld 88. 6 good 6 ab Broken

Edison new No 13 Apr. 12-89
Lamps made 18-
carbons mld 85-

Edison New No 14 Apr. 12-89
Lamps made 18-
Carbons mld 23.

Edison New No 15- Apr. 12-89
Lamps made 18-
Carbons mld 85-

Edison new No 16

Edison new No 17

Edison New No 18

Edison New No 19

Edison new No 20

Edison new No 21

Edison new No 22

Edison New No 23.

Edison New No 24 Apr-12-89
Lamps made 15
Carbons recd 86

Edison New No 25

Edison New No 26 Apr-12-89
Lamps made 15
Carbons recd 96

Edison New. No 27

Edison New No 28 Apr-12-89
Lamps made 40
Carbons rec. 117

Edison 5-X Special Coal for Carbons
Lamps Made 7
Carbons recd 8. 1 Broken

Edison Order New Sept. 3/89.
Recd No 1 and No 2 order from M.M. Fox
No 1. A. Reid 20 carbons, Lamps made 16
No 2 B. Recd 23 carbons, Lamps made 16

Order-No-1-XX May 6-89
Lamps made 15
Carbons recd 44

Order No 2 XX. May 6-89
Lamps made 15
Carbons recd 53

Order No 3 XX May 6-89
Lamps made 15
Carbons recd 41

Sept 10/89
Edison Order New No 3. C
Lamps made 15
Carbons recd 93.
Bal of carbons had little bulb on them

Edison Order New No 4. 6 Sept. 19/89
Lamps made 15
Cartons rcd 15 Bal had little falls on

Edison Order New No 5 6 Sept 19-89
Lamps made 15
Cartons rcd 26

No 1 = XXX Apr = 15 = 90
Lamps made 6
Cartons rcd 20

No 2 = XXX Apr 15 = 90
Lamps made 6
Cartons rcd 24

No 3 = XXX Apr = 15 - 90
Lamps made 6
Cartons rcd 22

No 4 = XXX Apr. 15 - 90
Lamps made 6
Cartons rcd 28

No 5 = XXX Apr 15 - 90
Lamps made 6
Cartons rcd 23

E 1 = XXX Apr 15 = 90
Lamps made 6
Cartons rcd 21

E 2 = XXX Apr 15 - 90
Lamps made 6
Cartons rcd 24

E 3 = XXX Apr 15 - 90
Lamps made 6
Cartons rcd 23

No 6 = XXX Apr. 28, '90
Lamps made 6
Carbons rec'd 20

No 7 = XXX
Lamps made 6 Apr. 28, '90
Carbons rec'd 30

No 8 = XXX Apr. 28, '90
Lamps made 6
Carbons rec'd 27

No 9 = XXX Apr. 28-90
Lamps made 6
Carbons rec'd 28

No 10 = XXX Apr. 28-90
Lamps made 6
Carbons rec'd 25

No 11 = XXX Apr. 28-90
Lamps made 5
Carbons rec'd 24

No 12 = XXX Apr. 28-90
Lamps made 5
Carbons rec'd 22

No 13 = XXX Apr. 28-90
Lamps made 5
Carbons rec'd 28

No 14 = XXX Apr. 28-90
Lamps made 5
Carbons rec'd 28

No 15 = XXX Apr. 28-90
Lamps made 5
Carbons rec'd 28

No 16 = XXX Apr 28 - 90
Lamps made 5
Carbons rec'd 20

No 17 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 18

No 18 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 17
Carbons lighted up unevenly

No 19 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 23

No 20 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 19

No 21 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 23

No 22 = XXX May 1 - 90
Lamps made 5
Carbons rec'd 22

No 23 = XXX May 8 - 90
Lamps made 5
Carbons rec'd 18
Carbons uneven

No 24 = XXX May 8 - 90
Lamps made 5
Carbons rec'd 18

No 25 = XXX May 20 - 90
Lamps made 5
Carbons rec'd 8

No 26 = xxx May 20 - 90
Lamps made 5
Carbons used 14

No 27 = xxx May 20 - 90
Lamps made 5
Carbons used 11

No 28 = xxx May 20 - 90
Lamps made 5
Carbons used 16

No 29 = xxx
Lamps made 5 May 20 - 90
Carbons used 17

No 30 = xxx May 20 - 90
Lamps made 5
Carbons used 12

No 31 = xxx May 23 - 90
Lamps made 5
Carbons used 11
Lamps all broke mercury stopped running in pumps

No 32 = xxx May 23 = 90
Lamps made 5
Carbons used 14, 1 arc

No 33 = xxx May 23 = 90
Lamps made 5
Carbons used 13

No 34 = xxx May 23. - 90
Lamps made 5
carbons used 14.

No 35 = xxx May 23/90
Lamps made 5
Carbons used 13
2 Broken, 4 carbons spoiled

No 36 = xxx May 23/90
Lamps made 5-
Carbons recd 14
1 Broken Spotted

No 37 = xxx May 31-90
Lamps made 5-
Carbons recd 12
1 Broken Spotted

No 38 = xxx May 31-90
Lamps made 5-
Carbons recd 14 1 Spotted

No 39 = xxx May 31-90
Lamps made 5-
Carbons recd 13

No 40 = xxx May 31-90
Lamps made 5-
Carbons rec'd 13
1 Lamp broken by accident

No 41 = xxx June 5-90
Lamps made 5-
Carbons recd 9

No 42 = xxx June 5-90
Lamps made 5-
Carbons recd 10. 1 Lamp arc

No 43 = xxx June 12-90
Lamps made 5-
Carbons recd 13- 1 arc

No 44 = xxx June 12/90
Lamps made 5-
Carbons recd 14

No 45 = xxx June 12-90
Lamps made 5-
Carbons recd 12
Carbons interm 1 arc on pump

No 46 = XXX
Lamps made 5-
Carbons rec'd 15-
June 12-90

No 47 = XXX
Lamps made 12
Carbons rec'd 23
June 14-90

No 48 = XXX
Lamps made 12
Carbons rec'd 25-
June 14-90

No 49 = XXX
Lamps made 12
Carbons rec'd 15-
1 Lamp Broken
June 14-90

No 50 = XXX
Lamps made 5-
Carbons rec'd 10
June 14-90

No 51 = XXX
Lamps made 5-
Carbons rec'd 14
2 Broken and the whole order was spoiled or ruined
June 14-90

No 52 = XXX
Lamps made 10
Carbons rec'd 14
1 Spoiled near clamps
June 26/90

No 53 = XXX
Lamps made 10
Carbons rec'd 10
June 26-90

No 54 = XXX
Lamps made 10
Carbons rec'd 15-
1 Lamp Spoiled on Lamp. Broken on Lamp
Bad spots on carbons near clamps
June 26/90

No 55 = XXX June 30 90
Lamps made 10
Carbons rec'd 21
1 Lamp spotted on tops

No 56 = XXX June 30 90
Lamps made 10
Carbons rec'd 19
1 Lamp spotted on side of carbon
near clamp

No 57 = XXX July 17 - 90
Lamps made 10
Carbons rec'd 16
2 Carbons broken

No 58 = XXX July 17 = 90
Lamps made 10
Carbons rec'd 16

No 59 = XXX July 17 - 90
Lamps made 10
Carbons rec'd 19

No 60 = XXX July 26 - 90
Lamps made 5
Carbons rec'd 15
1 Broken on lamps all the rest good

No 61 = XXX Jul 26 - 90
Lamps made 5
Carbons rec'd 15

No 62 = XXX July 26 - 90
Lamps made 5
Carbons rec'd 15 1 Spotted

No 63 = XXX Jul 26 - 9
Lamps made 5
Carbons rec'd 16

No 64 = XXX Aug - 6 - 90
Lamps made 5
Carbons rec'd 14
2 carbons unseen

No 65 = XXX Aug - 5 - 90
Lamps made 5
Carbons recd 14
1 carbon uneven

No 66 = XXX Aug 5 - 90
Lamps made 5
Carbons recd 15
2 carbons spotted and 2 uneven

No 67 = XXX Aug - 5 - 90
Lamps made 5
Carbons recd 12
1 carbon uneven

No 68 = XXX Aug - 5 - 90
Lamps made 5
Carbons recd 15
2 carbons uneven and 1 spotted

No 69 = XXX Aug - 5 - 90
Lamps made 5
Carbons recd 13. 1 carbon broken

No 70 = XXX Aug - 5 - 90
Lamps made 5
Carbons recd 11
2 carbons very uneven and spotted

No 71 = XXX Aug - 13 - 90
Lamps made 5
Carbons recd 8
1 carbon spotted

No 72 = XXX Aug - 13 - 90
Lamps made 5
Carbons recd 10
1 carbon spotted

No 73 = XXX Aug - 13 - 90
Lamps made 5
Carbons recd 10

No 74 = XXX Aug - 13 - 90
Lamps made 5
Carbons recd 13, carbons not good, rough on ends of bamboo & broken in cutting off
2 spotted 1 uneven

No 75 = XXX Aug - 13 - 90
Lamps made 8
Carbons rec'd 6
very poor carbons. black not shiny
1 Broken

No 76 = XXX Aug = 13 - 90
Lamps made 4
Carbons rec'd 4
Carbons very black by looking at them through glass but shine when looking at them with naked Eye
4 carbons uneven

No 77 = XXX Aug - 13 - 90
Lamps made 8
Carbons rec'd 10
2 carbons uneven

No 78 - XXX Aug - 13 - 90
Lamps made 8
Carbons rec'd 9
Carbons very black. small parcels sticking to them and 1 very uneven

No 79 = XXX Aug - 14 - 90
Lamps made 8
Carbons rec'd 11

No 80 = XXX Aug - 14 - 90
Lamps made 8
Carbons rec'd 13

No 81 = XXX Aug - 14 - 90
Lamps made 7
Carbons rec'd 4
1 Lamp made full length 2 carbons were short. carbons had small parcels on them & Broken in cleaning them off. 1 broken in exhausting and 2 spotted and uneven

No 82 = XXX Aug - 14 - 90
Lamps made 8
Carbons rec'd 8
8 carbons very uneven

No 83 = XXX Aug - 14 - 90
Lamps made 5-
Carbons recd 12

No 84 = XXX Aug - 14 - 90
Lamps made 5-
Carbons recd 12
1 carbon very uneven

No 85 = XXX Aug - 14 - 90
Lamps made 5-
Carbons recd 6
1 ~~carbon~~ spotted and 1 very uneven

No 86 = XXX Aug - - 90
Lamps made 5-
Carbons recd 11
2 spotted

No = 87 = XXX Aug - - 90
Lamps made 5-
Carbons recd 12
1 bad

No 88 = XXX Aug - - 90
Lamps made 5-
Carbons recd 12

No 89 = XXX Aug - 30 - 91
Lamps made 5-
Carbons recd 11
2 spotted

No 90 = XXX Aug - 30 - 90
Lamps made 3
Carbons recd 5-
2 broken, carbons very bad. burnt spots thru on

No 91 = XXX Aug - 30 - 90
Lamps made 5-
Carbons recd 10

No 92 = XXX Aug - 30 - 90
Lamps made 5-
Carbons recd 9
Carbons looked very ~~porous~~ and bad and 2 spotted

No 93 = xxx Aug-30-90
Lamps made 3
Carbons recd 3
Carbons stuck together. could get
but 3 out of them. 2 very narrow

No 94 = xxx Aug-30-90
Lamps made 5
Carbons recd 10
2 very narrow

No 95 = xxx Aug-30-90
Lamps made 5
Carbons recd 13

No 96 = xxx Aug-30-90
Lamps made 5
Carbons recd 10
Carbons looked very bad under glass
looked cracked and porous.
1 broken and 2 spoiled

No 97 = xxx Aug-30-90
Lamps made 5
Carbons recd 15

No 98 = xxx Aug-30-90
Lamps made 5
Carbons recd 11

No 99 = xxx Aug-30-90
Lamps made 5
Carbons recd 9

No 100 = xxx Aug-30-90
Lamps made 5
Carbons recd 11

No 101 = xxx Aug-30-90
Lamps made 5
Carbons recd 12

No 102 = XXX Aug - 30 - 90
Lamps made 5
Carbons recd 10

No 103 = XXX Aug - 30 - 90
Lamps made 5
Carbons recd 11

No 104 = XXX Aug - 30 - 90
Lamps made 5
Carbons recd 12

No 105 = XXX Aug - 30 - 90
Lamps made 5
Carbons recd 10

No 106 = XXX Aug - 30 - 90
Lamps made 3
Carbons recd 3

No 107 = XXX Aug - 30 - 90
Lamps made 5
Carbons recd 10

No 108 = XXX Sept - 4 - 90
Lamps made 3
Carbons recd 4
1 Broken and 1 spotted

No 109 = XXX Sept - 4 - 90
Lamps made 5
Carbons recd 12
1 Spotted

No 110 = XXX Sept - 4 - 90
Lamps made 5
Carbons recd 8
1 Spotted

No 111 = XXX Sept - 4 - 90
Lamps made 5
Carbons recd 12
1 spotted

No 112 = XXX Sept - 4 - 90
Lamps made 5
Carbons recd 10

No 113 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 10

No 114 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 13
1 spoiled

No 115 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 10

No 116 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 9

No 117 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 12

No 118 = XXX Sept - 6 - 90
Lamps made 5
Carbons recd 9
Small carbs shrink to carbons 2 of them broken in trying to clean them
1 spoiled

No 119 = XXX Sept - 15 - 90
Lamps made 5
Carbons recd 8
1 Broken 5 uneven

No 120 = XXX Sept - 15 - 90
Lamps made 5
Carbons recd 9

No 121 = XXX Sept - 18 - 90
Lamps made 5
Carbons recd 11 1 Broken

No 122 = XXX Sept-18-90
Lamps made 5
Carbons recd 12 — 2 Spotted

No 123 = XXX Sept-19-90
Lamps made 5
Carbons recd 10
carbons broked rubbed on side. 4 Spotted 1 are

No 124 = XXX Sept-19-91
Lamps made 5
Carbons recd 12

No 125 = XXX Sept-26-90
Lamps made 5
Carbons recd 11 — 1 Spotted

No 126 = XXX Sept-26-91
Lamps made 5
Carbons recd 9 — 1 Broken

No 127 = XXX Sept-26-90
Lamps made 5
Carbons recd 10

No 128 = XXX Sept-26-90
Lamps made 5
Carbons recd 9
1 Spotted and 1 mixum

No 129 = XXX Sept-26-90
Lamps made 5
Carbons recd 12

No 130 = XXX Sept-26-90
Lamps made 5
Carbons recd 7

No 131 = XXX Sept-26-90
Lamps made 5
Carbons recd 10

No-132 - xxx Sept-29-90
Lamps made 8-
Carbons rcd 10 — 2 minutes

No 133 = xxx Sept-29-90
Lamps made 8-
Carbons rcd 9

No 134 = xxx Sept-29-91
Lamps made 8-
Carbons rcd 12

No-135 - xxx Sept-29-90
Lamps made 8-
Carbons rcd 10

No-136 = xxx Sept-29-90
Lamps made 8-
Carbons rcd 10

No 137 = xxx Sept-30-90
Lamps made 8-
Carbons rcd 10 — 1 minute

No 138 = xxx Sept-30-90
Lamps made 8-
Carbons rcd 10

No 139 = xxx Sept-30-90
Lamps made 8-
Carbons rcd 8

No 140 = xxx Oct-6-90
Lamps made 8-
Carbons rcd 8 — 1 spotted

No 141 = xxx Oct-6-90
Lamps made 8-
Carbons rcd 11

No 142 = XXX Oct-6-90
Lamps made 5-
Carbons réd 11

No 143 = XXX Oct-6-90
Lamps made 5-
Carbons réd 12

No 144 = XXX Oct-6-90
Lamps made 5-
Carbons réd 8

No 145 = XXX Oct-6-90
Lamps made 5-
Carbons réd 7
8 Spotted

No 146 = XXX Oct-7-90
Lamps made 5-
Carbons réd 10

No-147 = XXX Oct-7-90
Lamps made 5-
Carbons réd 10

No-148 = XXX Oct-7-90
Lamps made 5-
Carbons réd 10

No 149 = XXX Oct-7-90
Lamps made 5-
Carbons réd 10

No 150 = XXX Oct-7-90
Lamps made 5-
Carbons réd 9

No 151 = XXX Oct-7-90
Lamps made 5-
Carbons réd 12

No 152 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 12
2 spotted and 1 uneven

No 153 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 8 — 1 Spotted

No 154 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 10 — 1 uneven

No 155 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 12
1 carbon Broken & 1 Spotted

No 156 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 11
1 Spotted and 1 uneven

No 157 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 12 — 1 Spotted

No 158 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 12 1 Spotted

No 159 = XXX Oct-9-90
Lamps made 5
Carbons rec'd 5 1 Spotted

No 160 = XXX Oct 25 — 90
Lamps made 4
Carbons rec'd 5 — 1 Broken

No 161 = XXX Oct-25-90
Lamps made 5
Carbons rec'd 12

No 162 = xxx Oct - 28 - 90
Lamps made 5
Carbons rec'd 11

No 163 = xxx Oct - 28 - 90
Lamps made 5
Carbons rec'd 9

No 164 = xxx Oct - 28 - 90
Lamps made 5
Carbons rec'd 11

No 165 = xxx. Oct - 28 - 90
Lamps made 5
Carbons rec'd 7

No 166 = xxx Nov - 3 - 90
Lamps made 5
Carbons rec'd 8
all spotted and worn

No 167 = xxx Nov - 3 - 90
Lamps made 5
Carbons rec'd 8

No 168 = xxx Nov - 11 - 90
Lamps made 5
Carbons rec'd 13 — 1 spotted

No 169 - xxx Nov - 11 - 90
Lamps made 5
Carbons rec'd 10
Carbons all burnt on pump when exhausting at 110 volts. they burnt over against the bulb if not kept a magnet under them all the while

No 170 = xxx Nov - 11 - 90
Lamps made 5
Carbons rec'd 10

No 171 – XXX
Lamps made 5 – Nov 11-90
Carbons recd 11 – 1 unburn

No 172 – XXX Nov – 20 – 90
Lamps made 5
Carbons recd 12 – 1 Broken

No 173 = XXX Nov – 20 – 90
Lamps made 5
Carbons recd 12 – 1 Broken by accident

No 174 = XXX Nov – 20 – 90
Lamps made 5
Carbons recd 12 – 1 Broken

No 175 = XXX Dec – 1 – 90
Lamps made 5
Carbons recd 12

176 = XXX Dec – 1 – 90
Lamps made 5
Carbons recd 11 – 1 Broken by accident

177 = XXX Dec – 1 – 90
Lamps made 5
Carbons recd 11 – 1 Spotted

No 178 = XXX Dec – 10 – 90
Lamps made 5
Carbons recd 11

No 179 = XXX Dec – 10 – 90
Lamps made 5
Carbons recd 7.
1 Broken by handling with tweezers
1 Spotted

No 180 = XXX Dec – 10 – 90
Lamps made 5
Carbons recd 10

No 181 = XXX Dec-18-90
Lamps made 5
Carbons recd 8

No 182 = XXX Dec-18-90
Lamps made 5
Carbons recd 11 - 1 burned

No 183 = XXX Dec-20-90
Lamps made 5
Carbons recd 10

No 184 = XXX Dec-20-90
Lamps made 5
Carbons recd 15

No 185 = XXX Jan-3-91
Lamps made 5
Carbons recd 10
1 Spotted

No 186 = XXX Jan 3 = 1891
Lamps made 5
Carbons recd 19 - All spotted in start we low current, but sum up after running. 1 Broken by accident

No 187 = XXX Jan-3-91
Lamps made 5
Carbons recd 20 - 5 burned same as No 186 - 1 Broken by accident

No 188 = XXX Jan-14-91
Lamps made 4
Carbons recd 5 - 1 split on top, all broke on pump when first plug was put in

No 189 = XXX Jan 14-91
Lamps made 5
Carbons recd 15
1 Platinum wire broke

No 190 = XXX Jan-14-91
Lamps made 3
Carbons rec'd 7 - 4 bal is short now
1 clamp melted

No 191 - XXX Jan-14-91
Lamps made 5
Carbons rec'd 13 - 1 arc

No 192 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 13 - 2 carbons broken
by accident

No 193 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 7 - OK

No 194 = XXX Jan 14-91
Lamps made 5
Carbons rec'd 13 - OK

No 195 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 10 -
1 carbon broken by cutting off
Bottom of Lamps - carbons all
uneven when first lighted but
evened up after running on
high current

No 196 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 15 - 1 uneven

No 197 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 15. OK

No 198 = XXX Jan-14-91
Lamps made 5
Carbons rec'd 13 — OK

No 199 = XXX Jan-23-91
Lamps made 5
Carbons rejd 13

No 200 = XXX Jan-23-91
Lamps made 5
Carbons rejd 17

No 201 = XXX Jan-23-91
Lamps made 5
Carbons rejd 7

No 202 = XXX Jan-23-91
Lamps made 5
Carbons rejd 22

No 203 = XXX Jan-23-91
Lamps made 5
Carbons rejd 15

No 204 = XXX Jan-23-1891
Lamps made 5
Carbons rejd 11

No 205 = XXX Jan-23-91
Lamps made 5
Carbons rejd 14

No 206 = XXX Jan-23-91
Lamps made 5
Carbons rejd 14

No 207 = XXX Jan-27-91
Lamps made 5
Carbons rejd 15

No 208 = XXX
Lamps made 5
Carbons rejd 14

No 209 = XXX Jan-27-91
Lamps made 5-
Carbons recd 15-

No 210 = XXX Jan-31-91
Lamps made 5-
Carbons recd 14

No 211 = XXX Jan-31-91
Lamps made 5-
Carbons recd 13

No 212 = XXX Jan-31-91
Lamps made 5-
Carbons recd 13

No 213 = XXX Feb-4-91
Lamps made 5-
Carbons recd 11

No 214 = XXX Feb-4-91
Lamps made 5-
carbons recd 10

No 215 = XXX Feb-4-91
Lamps made 5-
carbons recd 6

No 216 = XXX Feb-4-91
Lamps made 5-
Carbons recd 10

No 217 = XXX Feb-4-91
Lamps made 5-
Carbons recd 5

No 218 = XXX Feb-6-91
Lamps made
Carbons recd 10
not made up.

No 219 = xxx Feb-6-91
Carbon rod 15-
Not made up

No 220 = xxx Feb-6-91
Carbon rod 17
Not made up

No 221 = xxx Feb-6-91
Carbon rod 15-
Not made up

The foregoing xxx were ordered from Mr. Brown

Edison Experiments on lamps

Lamps made 6

•• 5-20-90
Lamps made 3
Made up of Iron Pyrites mixed with lamp material. half & half

••• May-20-90
Lamps made 3
Cyanite of silver mixed with lamp material. 1 of cyanite of silver 2 of lamp material

No. 2 ••• May-20-90
Lamps made 1
Lamps made with camphor ice small tube put in phosphorus cup

No 4 ... May-26-90
Lamps made 2
Lamps made with Coal Tar and
Lamp black for clamp material

No 5 ... May-26-90
Lamps made. not cut to test mm
Lamps made 1/2 Formade and 1/2
clamp material

No 6 ... May-26-90
Lamps made 2
Lamps made 1/2 Benzamide and 1/2
clamp material

No 7 ... May-27-90
Lamps made. not cut to test mm
Lamps made with 1/2 Formade
Ammonia and 1/2 clamp material

No 8 ... May 27-90
Lamps made 2
Lamps made 1/2 Chrysene + 1/2 Coal Tar
Thin down with Benzol. use air
just enough to spin it

No 9 ... May-27-90
Lamps made 2
Lamps made 1/2 Chrysene and 1/2
Gutta Percha soften in chloroform

No 10 ... May-27-90
Lamps made 2
Lamps made with Gutta Percha
softened with Chloroform and
Lamp Black added

No 11 ... 2 May-27-90
Lamps made
Lamps made with crude Rubber
dissolved in Bisulphide carbon
with Lamp Black added

No 12 . . .
Lamps made 2
Lamps made with Carbolic acid and ½ Clamp material

No 13 . . . May-28-91
Lamps made 5
Lamps made with Parafine and Gasoline put in a small tube on Phosphorus cup

No 14 . . . May-28-90
Lamps made 1
Lamps made with Camphor put in small tube on Phosphorus cup

No 15 . . . May-29-91
Lamps made 1
Lamps made with Parafine mixed with Gasoline and put on clamp

No 16 . . . May 29-90
Lamps made 5
Lamps made with Carbon dissolved in Parafine. No 1/16 carbon all covered twice. No 2 1/2 once. No 3/16 3/4 way No 4/16 1/2 way No 5/16 1/4 way

No 17 . . . May-31-91
Lamps made 3
Lamps made with Camphor on clamps covered with clamp material then covered with Gutta Percha dissolved in Chloroform

No 18 . . . May-31-90
Lamps made 2
Lamps made with clamp material Camphor and Chloroform mixed together with Rubber dissolved in Bisulphide Carbon put on outside

No 19 . . . May-31-90.
Lamps made 3
Lamps made with small tube
put in a tube on end of
Phosphorous cup filled with
Gasoline
No 1st Low current 1st not as low
No 3d Highest current 110 volts

No 20 . . . June-3-90
Lamps made 2
Lamps made with Ballade camphor
1 are on finish the stuff run
up on inside part and made
it are

No 21 . . . June-5-90
Lamps made 1
Lamp made with tube put on
Phosphorous cup with small
tube put inside fill with
Gasoline Lamp exhausted up
to 110 volts then run down to
yellowish white when tube broke
which was filled with Gasoline

No 22 . . . June-5-90
Lamps made 1
Lamp made with Gasoline tube
put in tube on Phosphorous cup
exhausted up to 110 volts. then
Gasoline tube broke when lamp
was burning then current run
down, yellowish white as vacuum
increased. the lamp grew bright

No 23 . . . June-5-90
Lamps made 1
Lamp made with Gasoline tube
put in tube on Phosphorous
cups. Exhausted up to 110 volts
then Gasoline tube broke while
lamp was burning at 110 volts
and as current and vacuum
increased. lamp was run down
and discolored. and carbon broke

No 24 . . . June 6-90

Lamps made 4

Lamps made with Gasoline tube put in tube on Phosphorous cup Exhausted up to 110 volts then plugged in resistance box, plug in at 8th hole from top then Gasoline tube broke and then plug put in No 2 hole and left there untill vacuum increased also as vacuum increased lamps grew brighter and then run off regular

No 25 . . . June 6-90

Lamps made 2 - 1 B. Chem on pump

Lamps made with Gasoline tube put Phosphorous cup. Exhausted up to 110 volts. also lamps heated up with bunsen burner to drive out all the air possible then Gasoline tube broke when lamp was burning at 110 volts, and vacuum increased and lamp grew brighter. the plugs were run down gradually untill 8th hole and left there untill tube was solid.

No 26 . . . June 6-90

Lamps exhausted up to 110 volts then current taken off then Gasoline tube broke. lamps run for 1 or 2 minutes and current put on lamps and then exhausted in regular style

No 27 . . . June 7-90

Lamps made 2

Lamps made with Gasoline tube put in tube on Phosphorous cup. exhausted up to 110 volts then run down to 102 volts and left there untill current went up and volts down to 85 then current taken off and lamps left to run solid

No 28 . . . June 7-90

Lamps treated same as No 27 excepting lamps run down from 102 volts to 90 volts on their own accord

No 29 . . . June - 9 - 90

Lamps made 2

Exhausted up to 200 volts. then lamps run down in current to 102 volts. then tube in tube on Phosphorus cup filled with Gasoline tube. and lamp allowed to run down to 85 volts. Then current thrown off and pumps let run solid and run off regular

No 30 . . . June - 10 - 90

Lamps made 2

Exhausted up to 110 volts. then tube in Phosphorus cup filled with Gasoline tube. lamps run down to 95 volts. then current taken off. let run solid this time there was Phosphorus in cup

No 31 . . . June - 11 - 90

Lamps made 2. with small quantity of Gasoline in tube on Phosphorus cup lamp run off regular up to 200 volts. then run down to 110 volts. then Gasoline tube broke. then lamps did not run down in current but the lamp grew brighter

No 32 . . . June - 11 - 90

Lamps made 4

Lamps made with Gasoline tube put in tube on Phosphorus cup filled up to Stitch lamps exhausted regular up to 200 volts then run down to yellowish white or down to 110 volts and lamps all current and resistance plugs put in at 2d tube on resistance box then Gasoline tube broke and lamps let run solid on pumps

No 33 . . . June - 11 - 90

Lamps made 4

No 33 is the exact duplicate of No 32 run off same on pumps

No 34 . . . June 21 - 90

Lamps made

Old resistance lamp from Lamp Co refused heated in Gasoline same as other orders have been done before

No 35 . . . June - 26 - 90
Lamps from Lamp Co. that are thrown away for bad. refined and treated in Gasoline by putting tube in tube on Phosphorous cups

No. 36 . . . July - 8 - 90
Lamps made 3
Lamps run off same as regular but the did not tear the clamps these lamps are old lamps from the lamp Co treated in Gasoline

No 37 . . . July - 8 - 90
Lamps made 3
No 37 Exhausted same as No 36 excepting the worked off the clamps

By: Emmons Ind Form

Experiments on Treated Carbons

No 1 10. Aug - 7 - 90
Lamps Treated 1
Treated with commercial alcohol the same as with Gasoline but no deposit on Glass or carbon burned on clamps

No 2 10. Aug - 7 - 90
Lamps Treated 2
Treated with Turpentine same as Gasoline. Carbon O.K. but burs on clamps

No 3. 10. Aug - 7 - 90
Lamps Treated 1
Treated with Chloroform deposit on carbon and also on bulb. pumps very dirty and would not run solid

No 4. 10 Aug - 8 - 90
Lamps Treated 1
Treated with oil of Mustard deposit on bulb and no deposit on carbon bulb very black

No 5. 1C Aug - 8 - 90
Lamps Treated 1
Treated with oil Peppermint no deposit on carbon or bulb

No 6 1C Aug - 8 - 90
Lamps Treated 2
Treated with Benzole deposit on carbon and black the bulb from carbon flake in bad spots

No 7 1C Aug - 8 - 90
One lamp treated with aniline no deposit on carbon pump run solid loan aniline in Phosphorus cup

No. 8 1C Aug - 8 - 90
One lamp treated with acetic Acid burned the carbon off when it should be treated. no good

No 9 1C. Aug - 9 - 90
2 Lamps treated with ½ Turpentine and ½ Gasoline. taken off treating pump and put on another pump to get a vacuum would not run solid with pump that it was treated with

No 10 1C. Aug - 9 - 90
1 Lamp treated with Formic Acid deposit on bulb and none on carbon

No 11 1C Aug - 9 - 90
2 Lamps treated with Tolu. bulb up spots on carbon but very little bad in voltage and blue on clamp

No 12 1C Aug 11 - 90
1 Lamp treated with oil aniline deposit on bulb and very little on carbon

No 13 LC Aug-11-90
One Lamp treated with one
Mixture of ½ Turpentine and ½
Gasoline. (No Good)

No 14-LC Aug-11-90
1 Lamp treated with Furfural
Got deposit and Broke carbon (No Good)

No 15-LC Aug-11-90
2 Lamps treated with Methol Alcohol
Good deposit on carbon and also on
bulb (very good result)

No 16-LC Aug-12-90
2 Lamps treated with Tolinol. Deposit
on carbon, also good deposit on bulb
also flux on clamps

No 17-LC Aug 12-90
1 Lamp treated with Acetone no
deposit or build on carbon

No 18 LC Aug-12-90
1 Lamp treated with amyl Nitrate. no
deposit on carbon or no build on
voltage

No 19-LC Aug-12-90
2 Lamps treated with Naphtha. good deposit
on carbon and flux on bulb. clamp flux

No 20-LC Aug-12-90
2 Lamps treated with amil acetate good
deposit on carbon. none on bulb little
flux on one clamp (very good result)

No 21-LC Aug-12-90
1 Lamp treated with oil cryolene no
deposit on carbon. (No Good)

No 22-LC Aug-12-90
3 Lamps treated with ½ Turpentine and
½ Gasoline good deposit on carbon very
little flux on clamp or bulb

No 23-10 Aug-13-90
1 Lamp treated with Turpentine and alchohol. deposit on bulb (No Gmd)

No 24-10 Aug-13-90
1 Lamp treated with alchohol and Rhigolene. deposit on bulb. (No gmd)

No 25-10 Aug-13-90
2 Lamps treated with ½ Turpentine and ½ Rhigolene very good except blue on clamps

No 26-10 Aug-13-90
1 Lamp treated with Naptha and Turpentine. deposit on bulb. (No Good)

No 27-10 Aug-13-90
Two Lamps treated with ½ Amyl-acetate and ½ Gasoline. Good result no blue on clamp and good deposit on carbon. (Best yet)

No 28-10 Aug-14-90
2 Lamps treated with wood alchohol and Turpentine very fine deposit on carbon and none on bulb but blue on clamps. (very good excepting blue

No 29-10 Aug-14-90
2 Lamps treated with wood-alchohol and Gasoline. very fine deposit on carbon and none on bulb (Best result excepting No 27)

No 30-10 Aug-14-90
2 Lamps treated with Acetate and Benzole. deposit on bulb. (No good)

No 31-10 Aug-13-90
1 Lamp treated with Formic acid and Gasoline. black on bulb but good deposit on carbon and blue on clamp

No 32 10 Aug-15-90
1 Lamp treated with Turpentine and Benzole. (Black bulb. No good)

No. 33 10 Aug-15-90
2 Lamps treated with acetate and alcohol. very good on carbon but very long in making. no black on bulb. no blue on clamp.

No 34 10 Aug-16-90
2 Lamps treated with acetate and Turpentine. quite good deposit on carbons but blue on clamps

No 35 10 Aug-18-90
2 Lamps treated with Rosine oil. no deposit on carbon. (No Good)

No 36-10 Aug-18-90
1 Lamp treated with oil Camphor. no deposit on bulb. (No Good)

No 37 10 Aug-18-90
1 Lamp treated with acetone very slow. deposit on carbon and very little build in Amipsed. (No Good)

No 38 10 Aug-18-90
2 Lamps treated with Alcohol & Ether very long in making but good deposit on carbon and not much blue on clamp. (Quite good result)

No 39-10 Aug-20-90
2 Lamps treated with Alcohol and Toluol. good deposit on carbon. bulbs not very black. no blue on clamps (very slow in making)

No 40 10 Aug-25-90
2 Lamps treated with Rosin oil. no deposit on bulb in carbon (No Good)

No 41-16. Aug-25-90
3 Lamps treated with Amylen good and quick deposit on carbon very little fine on clamp and very little black on bulb (Good Result

No 42-16. Aug-26-90
1 Lamp treated with Glycerine no deposit on carbon

No 43-16 Aug-27-90
3 Lamps treated with ½ Amylen and ½ Toluol very quick deposit no fine on clamps. Black bulbs very bad

No 44-16. Aug-27-90
1 Lamp treated with Animal oil very slow deposit on carbon black bulb and very fine on clamp treated with cup attached on the top of Lamp and heat with alcohol lamp

No 45-16 Aug-27-90
1 Lamp treated with venice Turpentine pump would not run solid (No Good)

No 46-16 Aug-28-90
2 Lamps treated with Rhigolene & Amylen very quick and good deposit on carbon bulbs a little discolored and very little fine on clamps but hard to get a vacuum after treating

No 47-16. Aug-28-90
2 Lamps treated with Turpentine and Amylen about same result as No 46

No 48-16. Aug-28-90
1 Lamp treated with Chloral & 1 H4 drop Pump would not run solid. to much moisture. (No Good)

No 49-16. Aug-29-90
2 Lamps treated with ½ acetate and ½ amylen. Good and quick deposit on carbon. no flue on clamps. and very little flash on bulb

No 50-16 Aug-29-90
2 Lamps treated with ½ amylen and ½ Lactolene. flue on clamps good deposit on carbon. and not very much flash on bulb

No 51-16 Aug-29-90
2 Lamps treated with alcohol and amylen. very quick build on carbon no flash on bulb and no flue on clamps. (very good result)

No 52-16 Sept-2-90
Lamps made 10
Duplicate of No 2-16.

No 53-16 Sept-9-90
1 Lamp treated with alcohol and chloroform. very slow deposit on carbon. and flash bulb (No Good)

No 54-16. Sept-9-90
2 Lamps treated with chloroform and Turpentine. very little deposit on carbon. and flash bulb

No 55-16 Sept-9-90
Lamps made 10
Duplicate of No 28-16

No 56-16 Sept-9-90
2 Lamps treated Turpentine and Acetone. no deposit on carbon

No 57-16 Sept-9-90
2 Lamps treated with alcohol & Methylene very quick build on carbon. no flash on bulb. but flue on clamps

No 58-1C Sept-9-90
2 Lamps treated first with oil of Citronella alone, no deposit on Carbon then mixed with ½ Gasolene and got quite good result, good deposit on carbon but flue on clamp and little black on bulb.

No 59-1C Sept-9-90
2 Lamps treated first with Creosote, no deposit so mixed with Naptha quite good deposit on carbon, flue on clamp.

No 60-1C Sept-10-90
2 Lamps treated with Cajeput alone (No good) mixed with Naptha quite good deposit on carbon, flue on clamp.

No 61-1C Sept-10-90
2 Lamps treated with Thyme alone very slow deposit and flue on clamp little black on bulbs

No 62-1C Sept-10-90
2 Lamps treated with ½ Acetone and ½ Alcohol quite good deposit on carbon, flue on clamps and discoloured bulbs.

No 63-1C Sept-10-90
2 Lamps treated with oil of Cardamon and Nitrate slow deposit on carbon black bulbs and broke carbons before run to lamps.

No 64-1C Sept-10-90
2 Lamps treated with oil of Cassia and Amyden very quick deposit on carbon and no black on bulbs, flue clamps

No 65-1C Sept-12-90
4 Lamps treated with ½ Amyden ½ oil of Camphor very quick deposit on carbon, no black on bulbs, flue clamps (as good as any we have treated on pump.

No 66-A. Sept-13-90
2 Lamps treated with oil of Mustard and Benzole good deposit on carbon but black bulb and fine clamp

No 67-A Sept-15-90
2 Lamps treated with amylen and Naptha good deposit on carbon. fine clamp no black on bulbs

No-68-A Sept-15-90
2 Lamps treated with oil of Caraway and wood alcohol very slow in depositing. fine clamp, but no black on bulb

No 69-A
Sept-15-90
2 Lamps Treated with Amylen and No Ether very little black on bulb very little fine on clamp but very slow in depositing

No 70-A Sept-19-90
3 Lamps treated with Benzole and amylen good deposit on carbon but bulbs very black

No 71 A. Sept-20-90
2 Lamps treated with acid Butyric (no good) broke carbons in spots

No 72 A. Sept-20-90
2 Lamps treated with acid Butyric and amylen broke carbons same as no 71

No-73-A Sept-20-90
3 Lamps treated Rosin oil and amylen good deposit on carbon very little fine on clamp no black on bulb

No 74-A Sept-22-90
2 Lamps treated with Furfurol broke carbons no deposit. No Good

No 75-U Sept 22-90
2 Lamps treated with amyl-acetate
treat carbon (no good)

No 76-U Sept-22-90
2 Lamps treated with oil of
Peppermint and amylene very slow
deposit on carbon. no black on
bulb, but bits on clamp

No 77-U Sept-22-90
2 Lamps treated with acetic aldehyde
very slow deposit on carbon. blue
clamps little black on bulb

No 78-U Sept-22-90
1 Lamp treated six minutes with
Cummins built only 1/10th part
of amp

No 79-U Sept-22-90
2 Lamps treated with amyl-Nitrate
and acetic acid aldehyde. good
deposit on carbon. blue clamps
no black on bulb

No 80-U Sept-22-90
1 Lamp treated with compressure
bulb very black and slow deposit
on carbon

No 81-U Sept-23-90
2 Lamps treated 1/2 Cummins and 1/2 Gasoline
good deposit on carbon. blue clamps
bulb little discolored

No 82-U Sept-23-90
2 Lamps treated with amylamine very
good and quick deposit on carbon
no black on bulb, but blue on clamps

No 83-10 Sept-23-90
2 Lamps treated with Ether Vaporous
quite good deposit on carbons no black
on bulb. blue clamp and lamps
would not run solid after treating

No 84-10 Sept-23-90
2 Lamps treated with Anisol. quite
quick to build. no black on bulbs
but a little blue on clamps

No 85-10 Sept-24-90
2 Lamps treated with Alcohol allylic
Good deposit on carbon. no black on
bulbs. but blue clamp

No 86-10 Sept 24-90
2 Lamps treated with Alcohol Amylic
very slow deposit on carbons no
black on bulbs but blue clamp

No 87-10 Sept-24-90
1 Lamp treated with Propylic Cumid
slow deposit on carbon. bulb very
black and blue clamp.

No 88-10 Sept-24-90
3 Lamps treated with Anisol and
Gasoline very good and quick
deposit on carbons no black on
bulbs. but little blue on clamps

No 89-10 Sept-24-90
2 Lamps treated with Alcohol allylic
and anisol. very slow deposit on
carbons and hard to run to vacuum
after treating. blue clamps

No 90-10 Sept-24-90
1 Lamp treated with Methol Formic
9 hours in treating. blue clamps

No 91-10 Sept-25-90
2 Lamps treated with Methol Cyanid
slow deposit. black bulb and blue clamp

No 92-10 Sept-26-90
1 Lamp treated with acid Camphronic
No build on carbon

No 93-10 Sept-26-90
3 Lamps treated with acid Camphronic
and anisol. black bulb. blue clamp
and very slow deposit on carbon

No 94-10 Sept-27-90
1 Lamp treated with anisol and amylen
slow to build. blue clamp and
black bulb

No 95-10 Sept-27-90
1 Lamp treated with Amylen (Duplicate
of No 41) only treated with Phorous
in cup

No 96-10 Sept-28-90
10 Lamps treated with amylen
(Duplicate of 41) treated without
Phorous in cup.

No 97-10 Sept-29-90
1 Lamp treated with Methol Cyanid and
anisol, very slow deposit on carbon
and blackened the bulb very bad

No 98-10 Oct-9-90
10 Lamps. (Duplicate of No 87

PUBLICATION AND MICROFILM
COPYING RESTRICTIONS

Reel duplication of the whole or of any part of this film is prohibited. In lieu of transcripts, however, enlarged photocopies of selected items contained on these reels may be made in order to facilitate research.

A Note on the Sources

The pages which have been filmed are the best copies available. Every technical effort possible has been made to ensure legibility.

102

END

FINANCIAL CONTRIBUTORS

PRIVATE FOUNDATIONS

The Alfred P. Sloan Foundation
Charles Edison Fund
The Hyde and Watson Foundation
Geraldine R. Dodge Foundation

PUBLIC FOUNDATIONS

National Science Foundation
National Endowment for the Humanities
National Historical Publications and Records Commission

PRIVATE CORPORATIONS AND INDIVIDUALS

Alabama Power Company
Amerada Hess Corporation
Anonymous
AT&T
Atlantic Electric
Association of Edison Illuminating Companies, Inc.
Battelle Memorial Institute
The Boston Edison Foundation
Cabot Corporation Foundation, Inc.
Carolina Power & Light Company
Consolidated Edison Company of New York, Inc.
Consumers Power Company
Corning Glass Works Foundation
Duke Power Company
Entergy Corporation (Middle South Electric Systems)
Exxon Corporation
Florida Power & Light Company
General Electric Foundation
Gould Inc. Foundation
Gulf States Utilities Company
Idaho Power Company
International Brotherhood of Electrical Workers
Iowa Power and Light Company
Mr. and Mrs. Stanley H. Katz
Matsushita Electric Industrial Co., Ltd.
McGraw-Edison Company
Minnesota Power
New Jersey Bell
New York State Electric & Gas Corporation
North American Philips Corporation
Philadelphia Electric Company
Philips International B.V.
Public Service Electric and Gas Company
RCA Corporation
Robert Bosch GmbH
Rochester Gas and Electric Corporation
San Diego Gas & Electric
Savannah Electric and Power Company
Schering-Plough Foundation
Texas Utilities Company
Thomas & Betts Corporation
Thomson Grand Public
Transamerica Delaval Inc.
Westinghouse Educational Foundation
Wisconsin Public Service Corporation

BOARD OF SPONSORS

Rutgers, The State University of New Jersey
Francis L. Lawrence
Joseph J. Seneca
Richard F. Foley
Rudolph M. Bell
New Jersey Historical Commission
Howard L. Green
National Park Service
John Maounis
Maryanne Gerbauckas
Nancy Waters
George Tselos
Smithsonian Institution
Bernard Finn
Arthur P. Molella

EDITORIAL ADVISORY BOARD

James Brittain, Georgia Institute of Technology
Alfred D. Chandler, Jr., Harvard University
Neil Harris, University of Chicago
Thomas Parke Hughes, University of Pennsylvania
Arthur Link, Princeton University
Nathan Reingold, Smithsonian Institution
Robert E. Schofield, Iowa State University

CORPORATE ASSOCIATES

William C. Hittinger (Chairman), RCA Corporation
Edward J. Bloustein, Rutgers, The State University of New Jersey *
Cees Bruynes, North American Philips Corporation
Paul J. Christiansen, Charles Edison Fund
Philip F. Dietz, Westinghouse Electric Corporation
Roland W. Schmitt, General Electric Corporation
Harold W. Sonn, Public Service Electric and Gas Company
Morris Tanenbaum, AT&T

*Deceased.

THOMAS A. EDISON PAPERS

Reese V. Jenkins
Director and Editor

Thomas E. Jeffrey
Associate Director and Microfilm Editor

Robert A. Rosenberg
Managing Editor, Book Edition

Helen Endick
Assistant Director for Administration

Associate Editor
Paul B. Israel

Research Associates
Theresa M. Collins
David W. Hutchings
Karen A. Detig

Intern
Gregory Jankunis

Assistant Editors
Keith A. Nier
Gregory Field
Lisa Gitelman
Martha J. King

Secretary
Grace Kurkowski

Student Assistant
Bethany Jankunis

Thomas A. Edison Papers
at
Rutgers, The State University
endorsed by
National Historical Publications and Records Commission
18 June 1981

Copyright © 1993 by Rutgers, The State University

All rights reserved. No part of this publication including any portion of the guide and index or of the microfilm may be reproduced, stored in a retrieval system, or transmitted in any form by any means—graphic, electronic, mechanical, or chemical, including photocopying, recording or taping, or information storage and retrieval systems—without written permission of Rutgers, The State University, New Brunswick, New Jersey.

The original documents in this edition are from the archives at the Edison National Historic Site at West Orange, New Jersey.

ISBN 0-89093-702-8.

Thomas A. Edison Papers

A SELECTIVE MICROFILM EDITION

PART III
(1887–1898)

Thomas E. Jeffrey
Microfilm Editor

Gregory Field
Theresa M. Collins
David W. Hutchings
Lisa Gitelman
Leonard DeGraaf
Dennis D. Madden
Mary Ann Hellrigel
Paul B. Israel
Robert A. Rosenberg
Karen A. Detig
Gregory Jankunis
Douglas G. Tarr

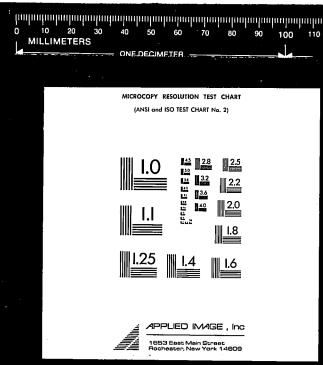
Editors

Reese V. Jenkins
Director and Editor

Sponsors
Rutgers, The State University of New Jersey
National Park Service, Edison National Historic Site
New Jersey Historical Commission
Smithsonian Institution

University Publications of America
Bethesda, Maryland
1993

Edison signature used with permission of McGraw-Edison Company.



14:1

Compilation © 1993 University Publications of America.
All rights reserved.